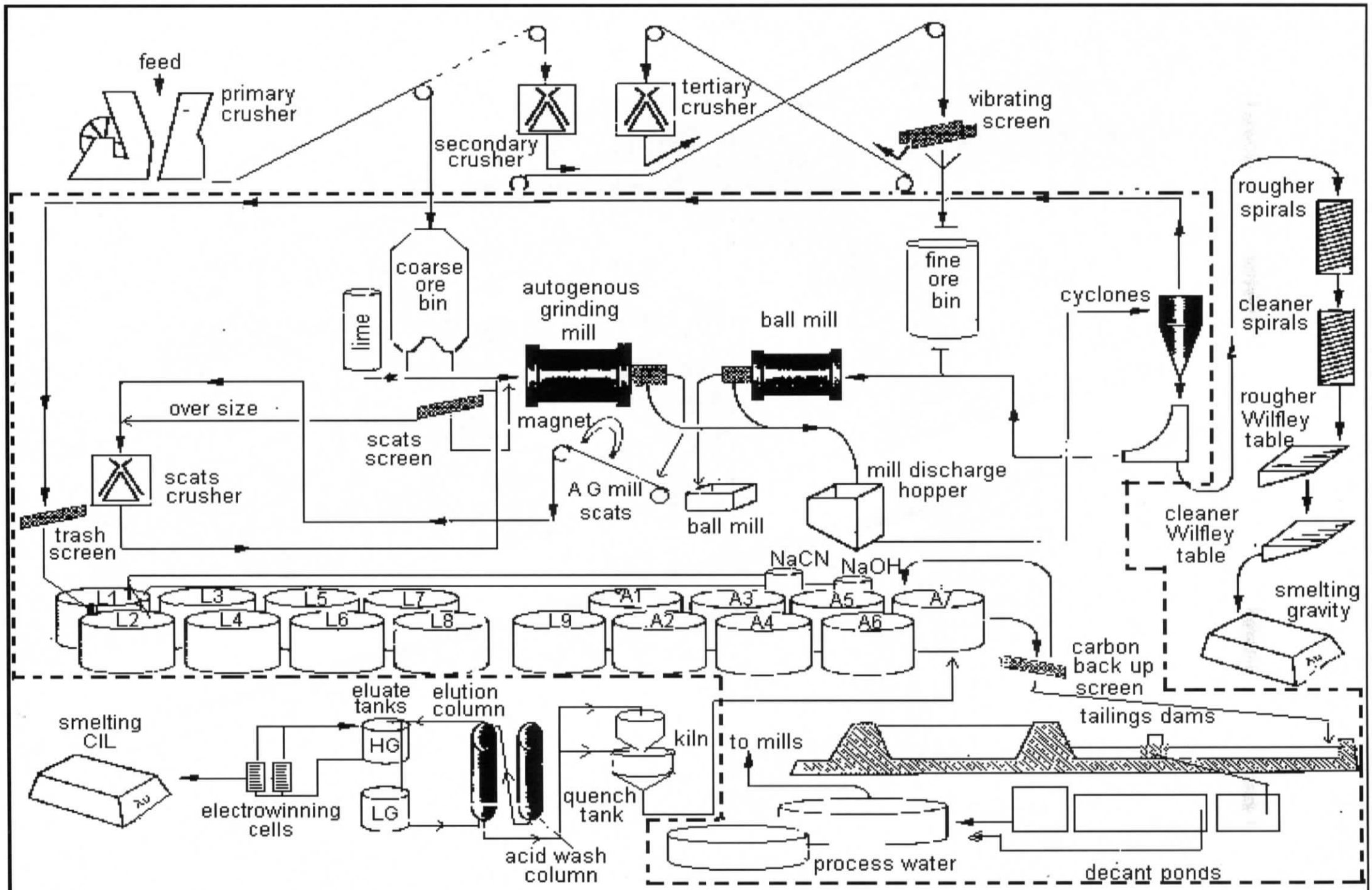
MILL OPERATIONS MANUAL

THE GRANITES GOLD MINE

Cartoons from page three onwards by Nigel Cook



Flow diagram of plant - the area within the dashed line is covered by this manual

K. Ward

TABLE OF CONTENTS

Many people have contributed towards this manual. Some have made direct input whilst others have spent hours editing all or part of it. Their efforts are much appreciated. For the writer it has been one hideous learning curve with respect both knowledge of the plant and the use of computer programs such as AutoCAD LT, Microsoft Word 7.0 and Paint Shop Pro.

As always the efforts of a few people has been far above the norm. These people will be acknowledged in name when the manual is revised early in 1996.

Until then the writer considers it prudent to accept all blame for errors and areas of contention. He would appreciate any constructive feed back in the mean time.

M.Hand November '95

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 INTRODUCTION AND HISTORY

Introduction

This manual attempts to fulfil three objectives, these being to:

- assist new operators in learning to operate the plant in a safe and efficient manner.
- promote agreement and uniformity among the present operators as to what is considered to be the most efficient method of plant operation.
- develop an awareness and acceptance of safety procedures amongst all personnel associated with the plant.

History

The original plant as completed in 1986 was comprised one ball mill in closed circuit with a set of six classifying cyclones. Cyclone overflow passed over a vibrating trash screen with 800 micron aperture. The screen underflow went directly to the C.I.P circuit, then comprised of two leach and six adsorption tanks, each with an effective capacity of 226 m^3. In 1989 this circuit was upgraded by the installation of an autogenous mill prior to the ball mill, a replacement set of ten cyclones and four new leach tanks, each with an effective capacity of 575 m^3. In 1990 a scats crushing circuit was added to the grinding circuit and two more 575 m^3 tanks added to the leach circuit. Late in 1994 an oversize screen was installed in the scats circuit to direct all oversize material back to the crusher whilst all under size scats were directed back to CV9. Late in 1995 two more 575 m^3 leach tanks were added to the circuit in order to restore residence time.

During this period the plant capacity has increased from 360,000 tonnes per annum to 1,400,000 tonnes per annum; the emphasis being on the need to maintain gold production with lower grade feed.

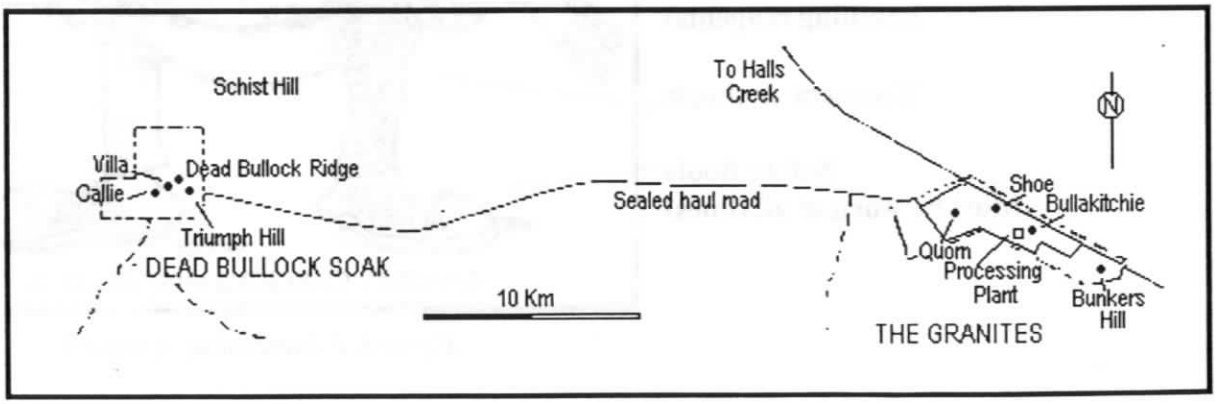


Figure 1.1 Dead Bullock Soak and the Granites

CHAPTER 2 PLANT SAFETY

Safety Notices

All notices must be observed. They are for your protection. Some warn of a hazard specific to a particular area, eg "Danger falling rocks" under a conveyor. Others indicate that specific safety apparel must be worn, eg ear plugs by the mill.

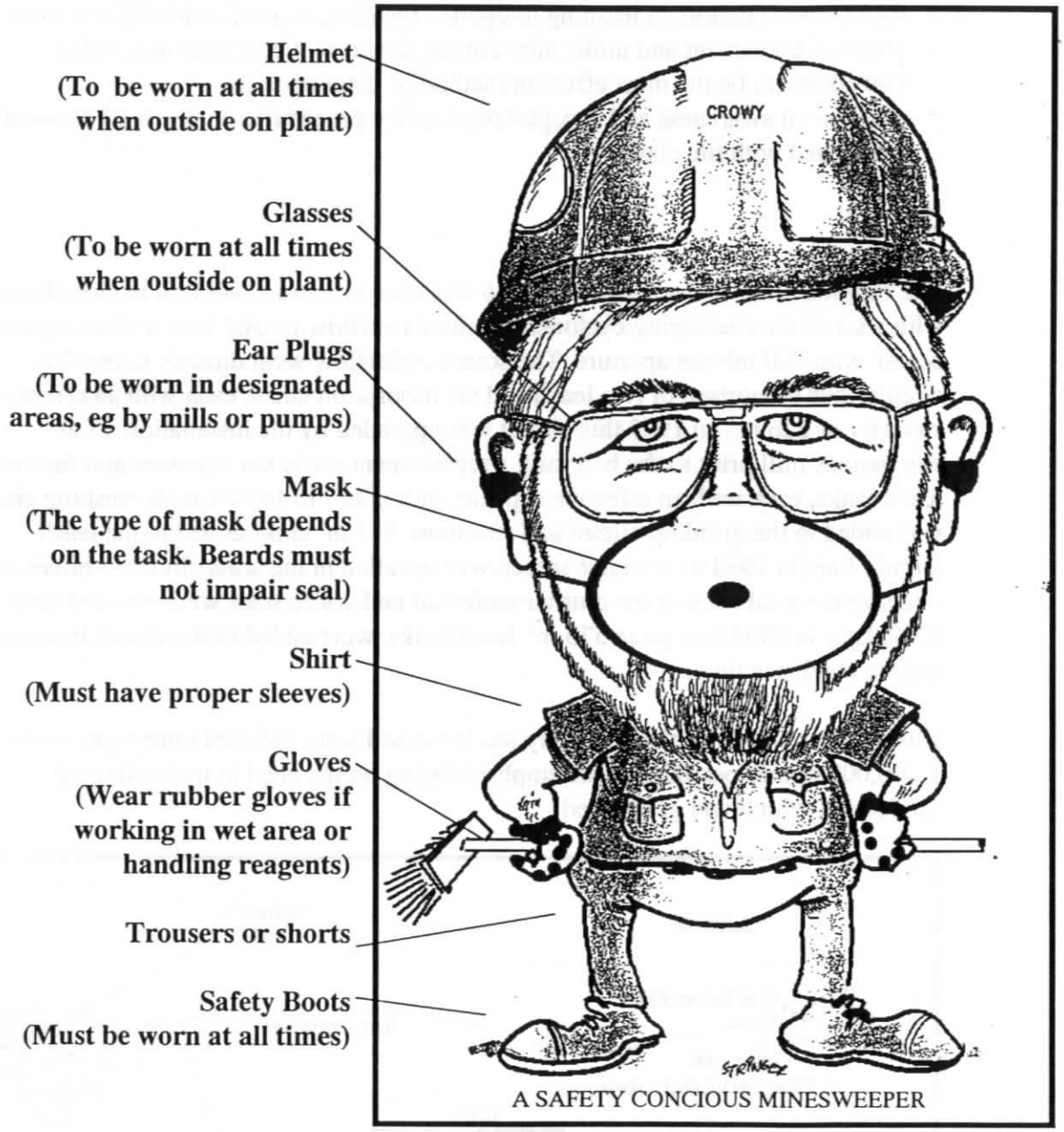


Figure 2. 1 Standard safety apparel

Safety Apparel

Figure 2.I illustrates the clothing standard for all personnel working in the plant area. All personnel are informed of this standard upon their arrival on site and hence have a

greater share in the responsibility for injury that may occur when not observing dress rules.

Emergency Contacts

Contact	Phone Nos	Room Nos.	Room Phone No.	Pager No.	Radio Chan.
Resident Manager	220	VIP3	273	10	1
Occ. Health & Safety Head	267	C20	256	10	8
Occ. Health & Safety Sisters	207 or 222	C16	264 or 222	1	8
Security Officers	289	E3/G2/E49	223	Nil	6
Mill superintendent	284	E24	204	Nil	30
General Foreman	238	D19	214	Nil	30
Mill Supervisor	285	E11	214	Nil	30
Maintenance Superintendent	251	E23	281	Nil	8
Maintenance supervisor	288	E21	281	Nil	30
Maintenance supervisor	288	C19	244	Nil	30

Table 2.1 Emergency contacts.

IMPORTANT

If reporting an emergency, clearly state the location and description of the accident, number of injured persons and do not leave the phone until advised to hang up.

Do not attempt to move an injured person. Wait for the people with the right equipment and skills. Even if you have the right equipment for a situation you should wait for back up personnel before attempting to assist an injured person who is in a hazardous situation. Do not endanger your own life too.

Safety Showers

Figure 2.2 shows the location of emergency showers and eye wash stations throughout the mill area. It is the responsibility of all personnel to ensure that these are kept clean and in a workable condition. It is a good idea to make a habit of trying out both the shower and the eye wash water valves when passing these stations. This helps to keep the valves and spray nozzles clear and to a degree also helps to stop build up of hot water in the immediate water lines.

Always wash immediately affected body parts or clothing should they come into contact with reagents such as hydrochloric acid, cyanide, caustic soda and lime. Always attempt to remove foreign bodies from eyes by using the eye wash station. If this fails then report to the clinic immediately.

Fire fighting

The location of fire extinguishers is shown on figure 2.2. Personnel should constantly check to ensure that these extinguishers have not been tampered with and that they are in good repair. Take to time to read the instructions before a fire occurs.

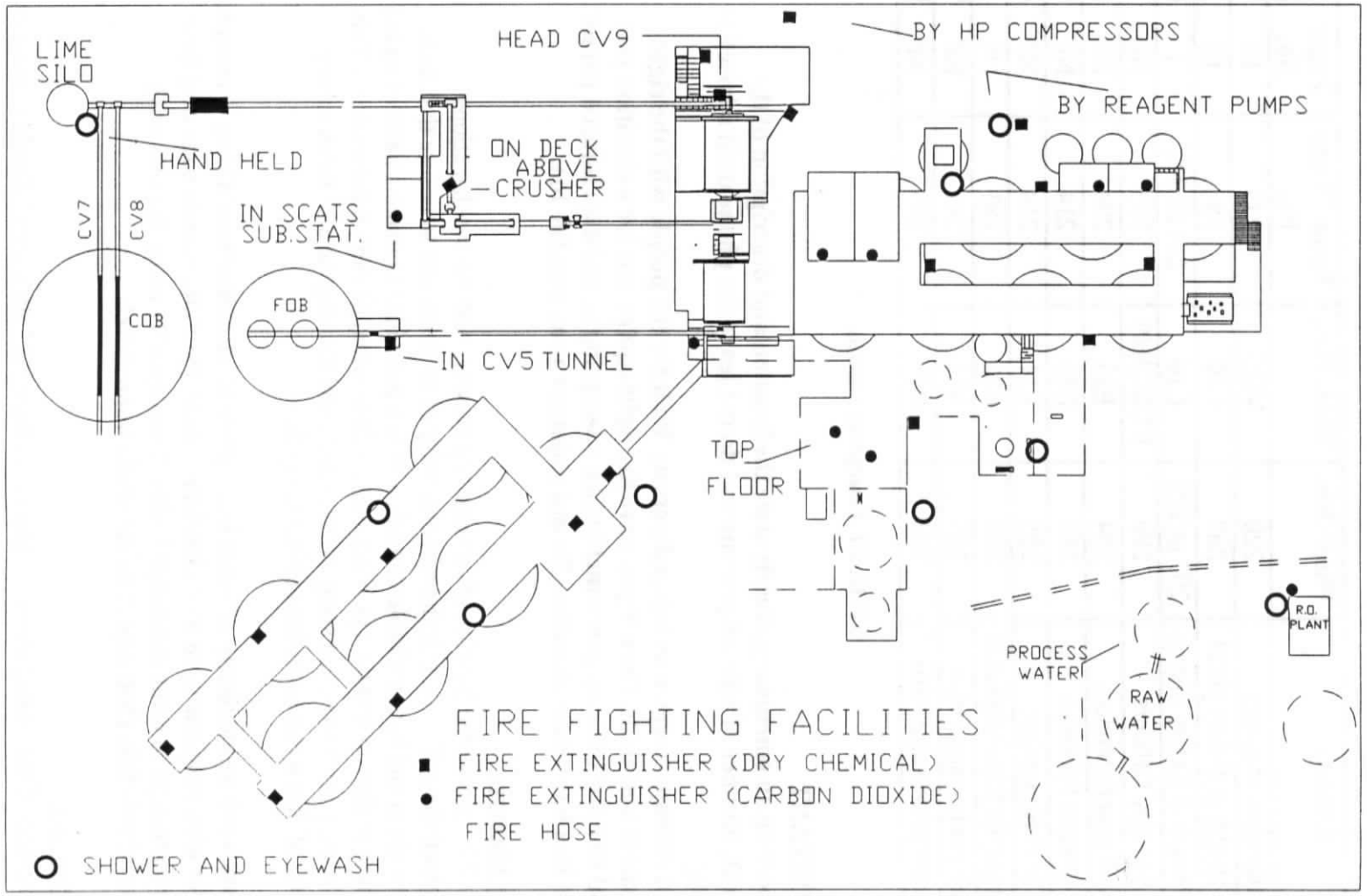


Figure 2.2 Location of fire fighting equipment and eyewash stations.

Tag Placement and Lockout Procedures.

Tag placement and lock out procedures have been established to isolate machinery and electrical equipment that could cause injury or damage if it were accidentally started or energised. Types of tags used on site include:-

PERSONAL DANGER TAGS.
These are designed to protect personnel and must be used to isolate equipment when there is a risk of injury should the equipment be accidentally started..

Each person working on the equipment must place his own tag. This tag can only be removed by the person who attached it or a supervisor who has established that the person involved has left site.

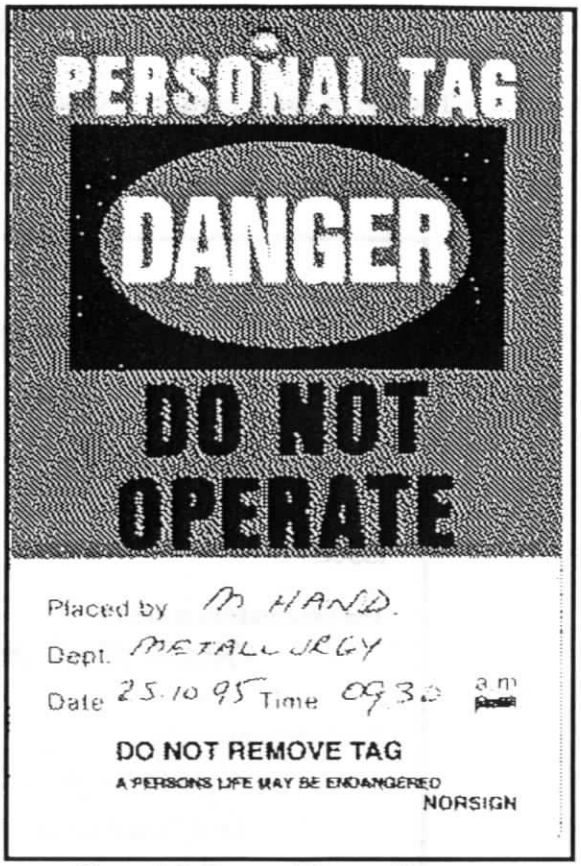


Figure 2.3 Personal Danger Tag

OUT OF SERVICE TAGS

These tags indicate that equipment is out of service and must not be used unless authorised by a supervisor.

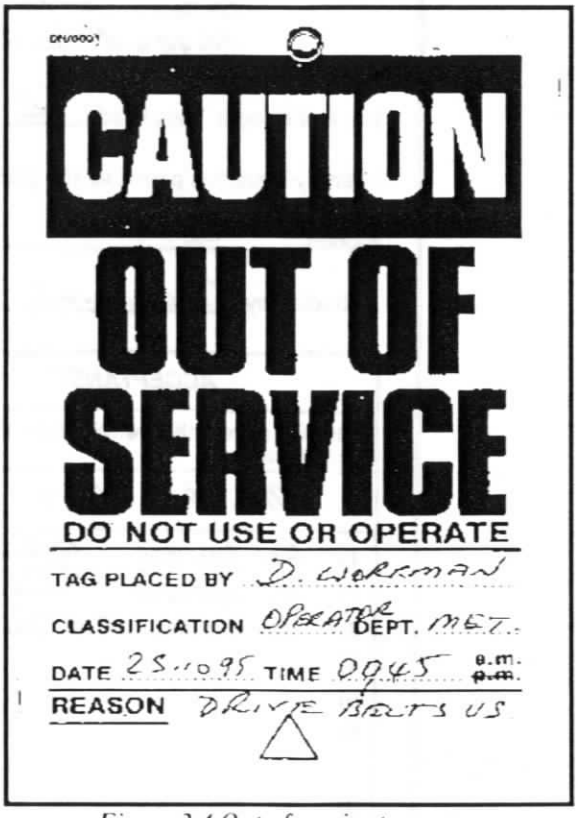


Figure 2.4 Out of service tag

MECHANICAL ACCESS PERMITS

The use of these permits is described fully in relevant sections of this manual. These permits are required when ever work is to be carried out in a confined space, and must be completed and authorised by a supervisor prior to any work taking place.

THE GRANITES GOLD MINE

MECHANICAL ACCESS PERMIT

No. 500

Date Issued 25, 10, 95 Date Cancelled 25, 10, 95

ISSUE

This permit allows access to:

THE A. G. MILL

For the following work:

Tightening of lifter bolts and inspection of shell

The following precautions to provide safe access have been taken:

main breaker isolated and tagged out. Local station tagged out.

No. # of Danger Tags fitted 4 No # of Locks fitted 1

I hereby issue this permit for the plant and purpose above:

Signed _____ Position MILL SUPERVISOR

Instructed by D Workman Time 0930 Date 25, 10, 95

ACCEPTANCE	SURRENDER
I hereby accept this permit under the above conditions.	I hereby surrender access to the above plant.
METALLURGY Section	METALLURGY Section
1) W. SMITH W Smith	1) W. SMITH W Smith.
2) M. HAND	2) M. HAND
3) D. WORKMAN D Workman	3) D. WORKMAN D Workman.
4)	4)
5)	5)
6)	6)
7)	7)
8)	8)

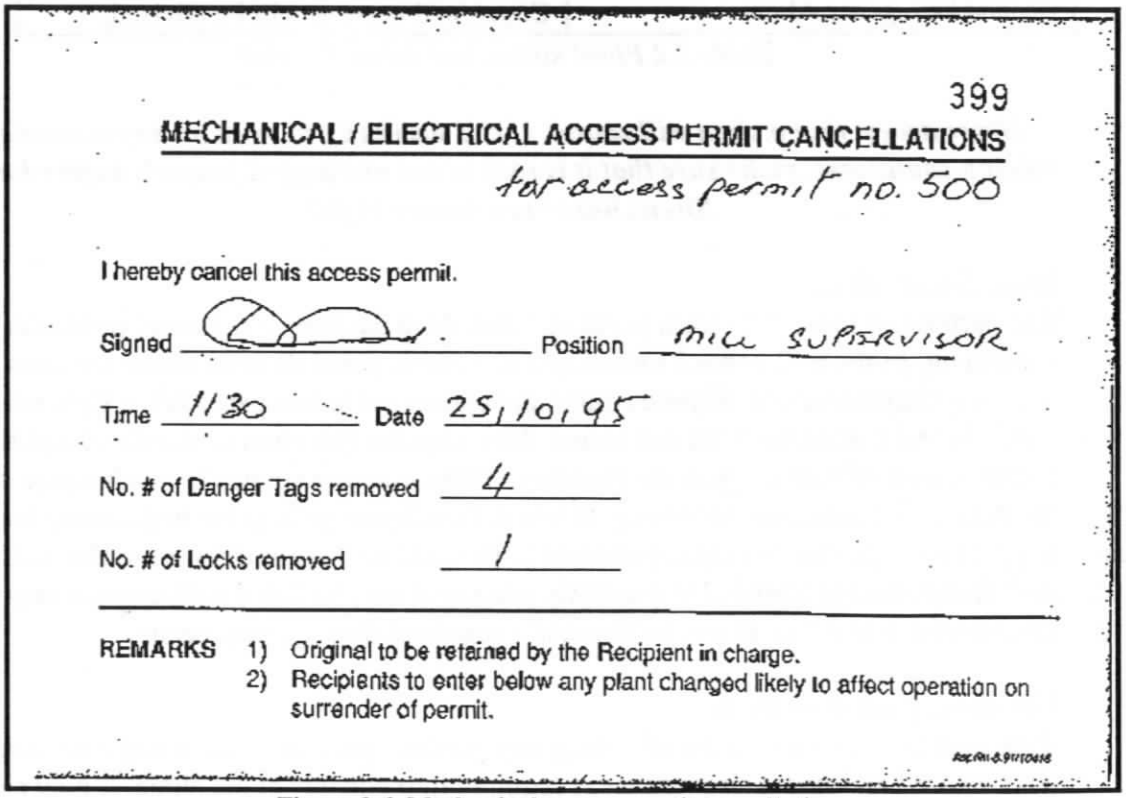
Figure 2.5 Completed mechanical access permit

Details required on the mechanical access permit include :-
Date when issued and when cancelled.
Location of the work
Description of the work to be done
Precautions taken prior to entry
Number of tags and locks fitted.
The signature of the person authorising the work
The signature of the person supervising the work
The signatures of all people who will be working in the confined space.
The signatures of all of the above people when they vacate the confined space.

A MECHANICAL ACCESS PERMIT CANNOT BE CANCELLED UNTIL ALL EQUIPMENT HAS BEEN REMOVED AND ALL PERSONNEL HAVE LEFT THE CONFINED SPACE AND HAVE SIGNED OFF THE PERMIT.

SHOULD A WORKER LEAVE THE WORK SITE WITHOUT SIGNING OFF THE PERMIT HIS SUPERVISOR MUST DETERMINE HIS WHERE-ABOUTS AND SEE THAT HE SIGNS THE PERMIT. THE SUPERVISOR MAY ONLY SIGN OFF A WORKER IN CASES WHERE IT HAS BEEN FIRMLY ESTABLISHED THAT THE WORKER HAS LEFT THE LEASE.

When all of the workers have removed their tags and signed off the access permit, the person in charge may complete the "mechanical/electrical access permit cancellation" form. The number of the original Access permit should be noted on this form



399

MECHANICAL / ELECTRICAL ACCESS PERMIT CANCELLATIONS

for access permit no. 500

I hereby cancel this access permit.

Signed _____ Position MILL SUPERVISOR

Time 1130 Date 25/10/95

No. # of Danger Tags removed 4

No. # of Locks removed 1

REMARKS 1) Original to be retained by the Recipient in charge.
2) Recipients to enter below any plant changed likely to affect operation on surrender of permit.

Figure 2.6 Mechanical access permit cancellation

Warning Sirens

Plant start up sirens

The remote start up of any major equipment, such as crushers, screens, conveyors and mills, is preceded by the sounding of a warning siren. Should a siren sound workers must stand clear of such equipment. All personnel should learn to recognise the sirens for specific areas.

The various sirens.	Desired Response
Sequence start.	Stand clear of equipment
Mill starting	Stand clear
Conveyor belt/s starting	Stand clear - rocks could roll off.
Equipment failure	Check out problem - get maintenance assistance if needed.
Powerhouse alarm	Call maintenance immediately.
High NaCN level in the mixing tank.	Shut off fill valve.
Gold room equipment malfunction	Check out - call out gold room staff and/or maintenance if needed.
Gold room security	Call security and/or gold room staff. Never be complacent about alarms. A robbery could occur. Always report the presence of strangers at night to security.
Blasting of oversize rocks at crusher	Do not go near the crusher or the pad.
General Emergency Alarm	Concerned persons will be advised.

Table 2.2 Plant sirens and desired action

Never accept that a siren will sound. If it is necessary to work on any normally moving equipment, make sure that it is racked out and tagged properly before hand. Sirens have been known to fail.

Plant failure sirens

The purpose of these is to warn personnel that there has been a failure of particular equipment. In the mill control room there is a mimic panel directly above the scats crushing circuit controls. Should equipment connected to this panel fail, a light will come on and a warning siren will sound. Never ignore this siren or simply accept that someone else will investigate the problem. This siren also sounds for such things as the A.G. Mill feed chute becoming blocked, tank levels getting too high, pump feed hopper levels getting too high, problems in the gold room or mill lube problems. If such things are not attended to promptly personnel may be faced with unnecessary clean up work and loss of production and equipment damage may occur.

Emergency services siren

This siren is sounded to warn all emergency services personnel that a major accident has occurred and that their presence is required immediately at the clinic. It may also serve to warn all personnel that a major hazard exists, eg fire in the powerhouse, leaking gas or a reagent spill has occurred. All personnel should find out the reason

for the sounding of this siren as soon as possible and if necessary ensure that their workmates are aware of the problem. Emergency services will endeavour to advise all personnel via the public address system, phone and radio should there be a hazardous situation in an area. These communication systems could fail in some situations so it is the responsibility of all personnel to see that warnings are passed on. This siren in tested each month. Personnel are warned in advance of the actual time.

Occupational Health Services.

Contact	Phone Nos	Room Nos.	Room Phone No.	Pager No.	Radio Chan.
Occ. Health & Safety Sisters	207 or 222	C16	264 or 222	1	8

Nursing Sisters

The sister on site is on call twenty four hours a day. Should an emergency occur the sister can be contacted by phone, radio or public address system. If the sister is not in either clinic she or he may be summoned by pressing the red button outside the clinic. This button is only reliable if the sister is in the relevant area. The button outside the plant clinic cannot be relied upon to contact the sister if she or he is in the camp or underground. In cases of emergency when the clinic is unattended, enter the clinic and use the phone or radio to summon the sister. Both clinics are left unlocked twenty four hours a day and personnel can personally attend to minor injuries or get a fellow worker with first aid experience to assist. In such cases do the right thing - leave a note for the sister, detailing the injury and items used. This protects you against possible complications later on.

Emergency Service Personnel

These personnel undergo continuous training throughout the year and are on twenty four hour call whilst on site. Should a major accident occur they will be contacted as deemed necessary by the sister on duty. Always advise the sister if additional assistance is thought necessary. Tending an injured person can be difficult and hazardous under some circumstances. Don't just accept that your assistance will be sufficient. You may not have the required training for coping with a particular incident.

Remember

If reporting an emergency, clearly state the location and description of the accident, number of injured persons and do not leave the phone until advised to hang up.

Do not attempt to move an injured person. Wait for the people with the right equipment and skills. Even if you have the right equipment for a situation you should wait for back up personnel before attempting to assist an injured person who is in a hazardous situation . Do not endanger your own life too.

Hazardous Chemicals

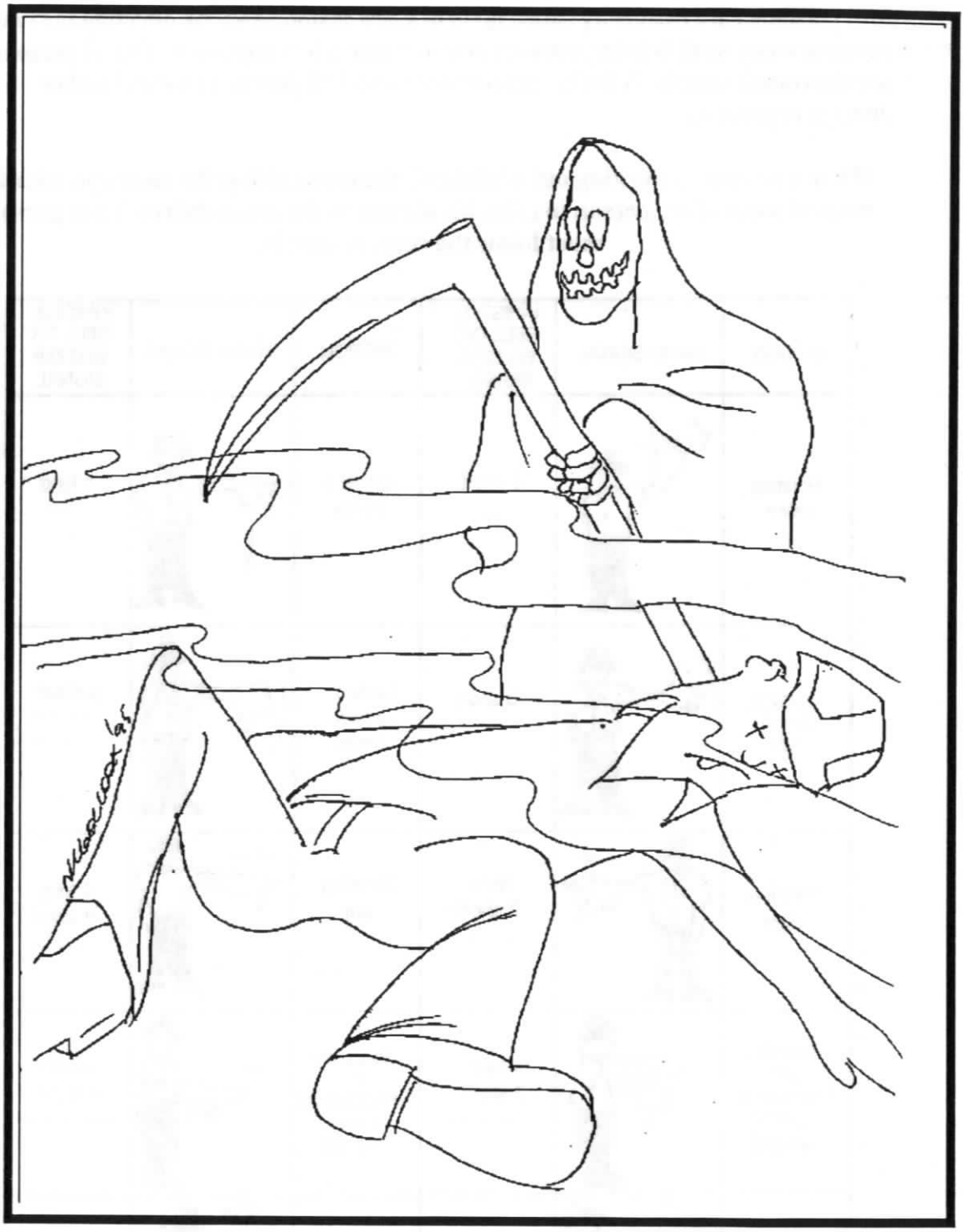
Mill personnel may have to handle the chemicals listed in the table below on a regular basis. Data sheets for specific chemicals are in appendix 1. (page 73)

Chemical	**Safety Apparel Required in** Addition to normal working clothes, helmet and safety boots.
Carbon in Pulp Circuit	
Lime	Mask, safety glasses, PVC gloves
Caustic Soda (Sodium Hydroxide)	Mask, safety glasses, PVC gloves and PVC apron or wet weather gear.
Cyanide (Sodium Cyanide)	Mask, safety glasses, PVC gloves and protective overalls.
Viscosity Modifiers	
Polyacrylate (Freevis)	PVC gloves and glasses.
Titration Chemicals	
Silver Nitrate	Safety glasses **
Rhodanine	Safety glasses **
	(** Wash off after body contact)
Acid Washing of Carbon	
Hydrochloric Acid	Safety glasses, PVC Gloves and apron- keep clear of pipeline when pumping.
Cleaning of Screens	
Hydrochloric Acid.	Mask, safety glasses, PVC gloves, wet weather gear or PVC apron.
Nitric Acid	Mask, safety glasses, PVC gloves, wet weather gear or PVC apron

Table 2.3 Hazardous Chemicals

All chemicals should be treated as potentially hazardous. If there is any doubt as to the correct handling procedure for a particular chemical contact your supervisor or the Occupational Health and Safety Officers. (phone 267 or 207).
Always wash chemicals off your body or clothing when splashed. Some chemicals such as hydrochloric acid and caustic soda can still cause nasty burns after the affected areas of contaminated clothing have been `diluted' by the addition of water.

PLAY SAFE - CHANGE YOUR CLOTHES IF CONTAMINATED.
ALWAYS WASH EXPOSED PARTS OF YOUR BODY BEFORE EATING, DRINKING OR SMOKING.
ALL POTENTIALLY HAZARDOUS AREAS HAVE SHOWER/EYEWASH STATIONS.



FUMES DO KILL

Crane Signals

Mill personnel are frequently called upon to assist maintenance by directing the crane operator when work is being done on or in the tanks. It is imperative that all personnel use the correct signals. A faulty signal could result in injury to personnel and/or damage to property.

When a person is working out of sight of the crane driver he must specifically request some other person to relay his signals to the crane driver. That person must know the correct signals.

MOTION	HAND SIGNAL	WHISTLE BELL OR BUZZER SIGNAL	MOTION	HAND SIGNAL	WHISTLE BELL OR BUZZER SIGNAL
Hoisting raise		2 short ··	Hoisting lower		1 long —
Luffing boom up		3 short ···	Luffing boom down		4 short ····
Slewing right		1long 2 short — ··	Slewing left		1 long 1 short — ·
Jib-trolley out Telescoping boom extend		1 long 3 short — ···	Jib-trolley in. Teslescoping boom retract		1 long 4 short — ····
Travel and traverse		not applicable	STOP		1 short
CREEP SPEED: APPROPRIATE HAND SIGNAL WITH HAND OPENING AND CLOSING					

CHAPTER 3 THE PLANT DESCRIBED

The Grinding Circuit

The function of the grinding circuit is to reduce the size of ore so that the valuable mineral particles are liberated from the gangue (non valuable minerals and waste), or exposed so that they may be recovered in further processing

The Autogenous Grinding Mill

The feed for the A. G. Mill comes from the coarse ore bin, which has a live capacity of 3,500 tonnes. Ore passes from two slot feeders at the base of the bin on to two variable speed 1.1 m wide hydraulically driven apron feeders,AF1 and 2, and from these feeders on to two fixed speed 1.5 m wide conveyors,CV7 and 8. which in turn discharge on to CV9, the one metre wide feed conveyor to the mill. If need be CV9 may also be fed via the passive feeder on to CV14 (1.5m wide). In recent years the ratio of local primary ore in blends has dropped considerably and now at least 80% of the A. G Mill feed would pass 75 mm.

The primary grinding autogenous mill (A.G. Mill) is a Morgardshammar grate discharge mill, 6.8 metres in length and 4.2 metres in diameter. The lining is of manganese steel grids with rubber discharge grates. The feed end has steel lifters and those of the discharge end are rubber.

The mill is powered by a 1250 kW motor, and a 250 / 125 kW auxiliary motor, coupled through main and auxiliary gear boxes. This configuration provides the mill with five fixed speeds by running the auxiliary drive at different speeds and directions through a planetary gear arrangement. Each motor is connected to this gear unit via a fixed coupling and has its own brake. When inching the main motor is prevented from starting and its brake is locked.

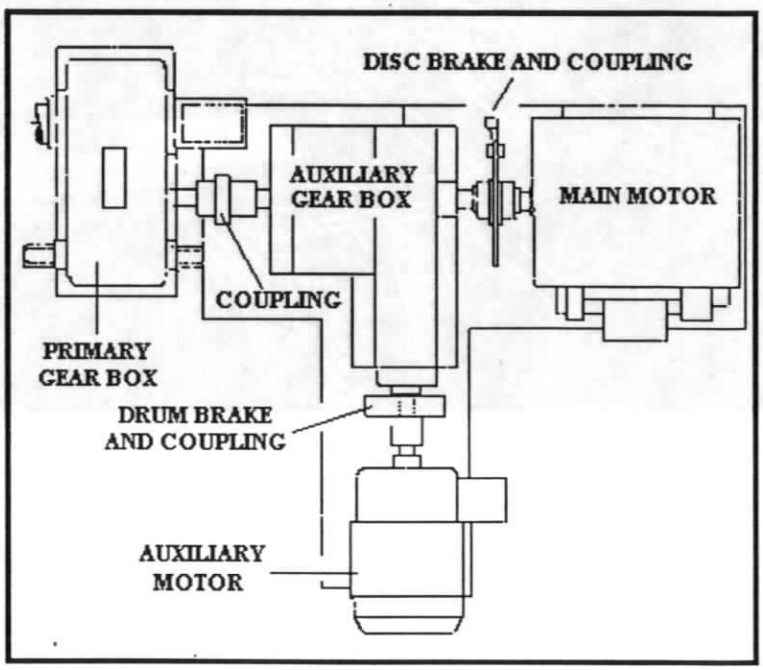


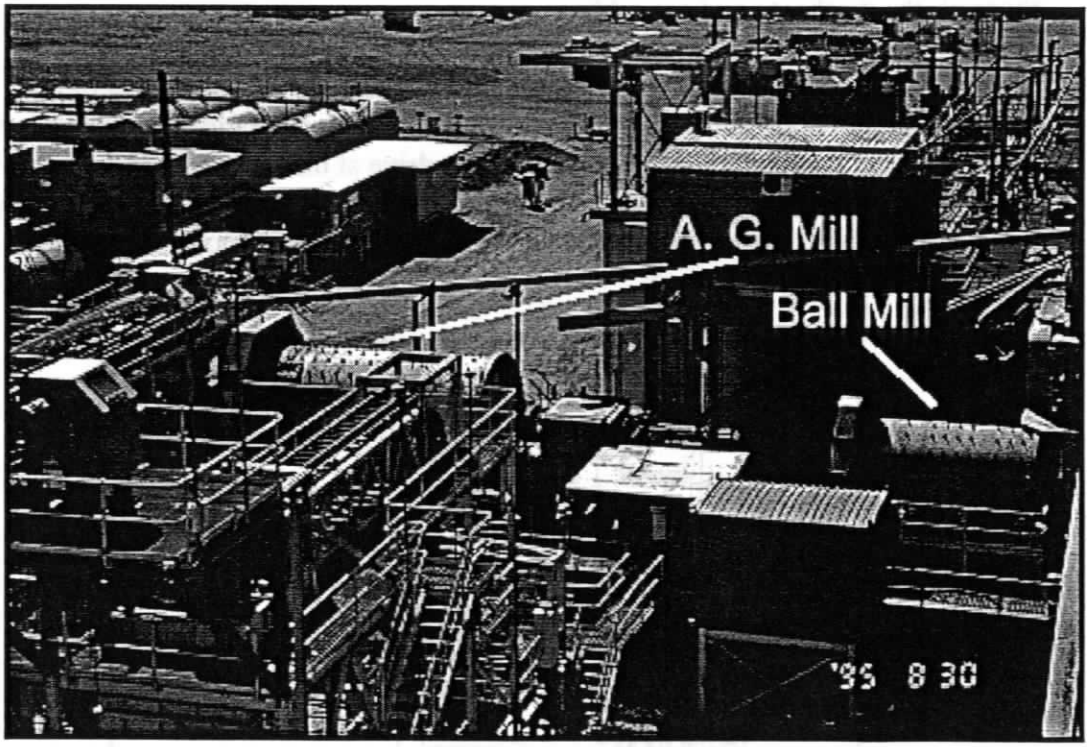
Figure 3.1 The A. G. Mill drive arrangement.

The power demand shown in the table below does not relate to the Inching only Speed.

Speed Selected	Mill Power Demand kW	Aux. Drive Direction	Aux. Drive Speed (rpm)	Mill Speed (rpm)	Inching only Speed
5	1500	Reverse	1500	18.62	Full
4	1375	Reverse	750	16.92	Half
3	1250	Stationary	0	15.23	0
2	1125	Forward	750	13.54	Half
1	1000	Forward	1500	11.84	Full

Table 3.1 - Auxiliary motor speed and direction related to mill power demand and speed.

Mill discharge passes from the mill through 50mm slots and from there into a double screen trommel. The inner screen has 25 mm apertures and it serves to separate out the coarser material scats, hence aiding in segregation of material and protecting the outer 13 mm screen. The plus 13 mm scats pass into the scats crushing circuit whilst the under 13 mm product passes into the mill discharge hopper.



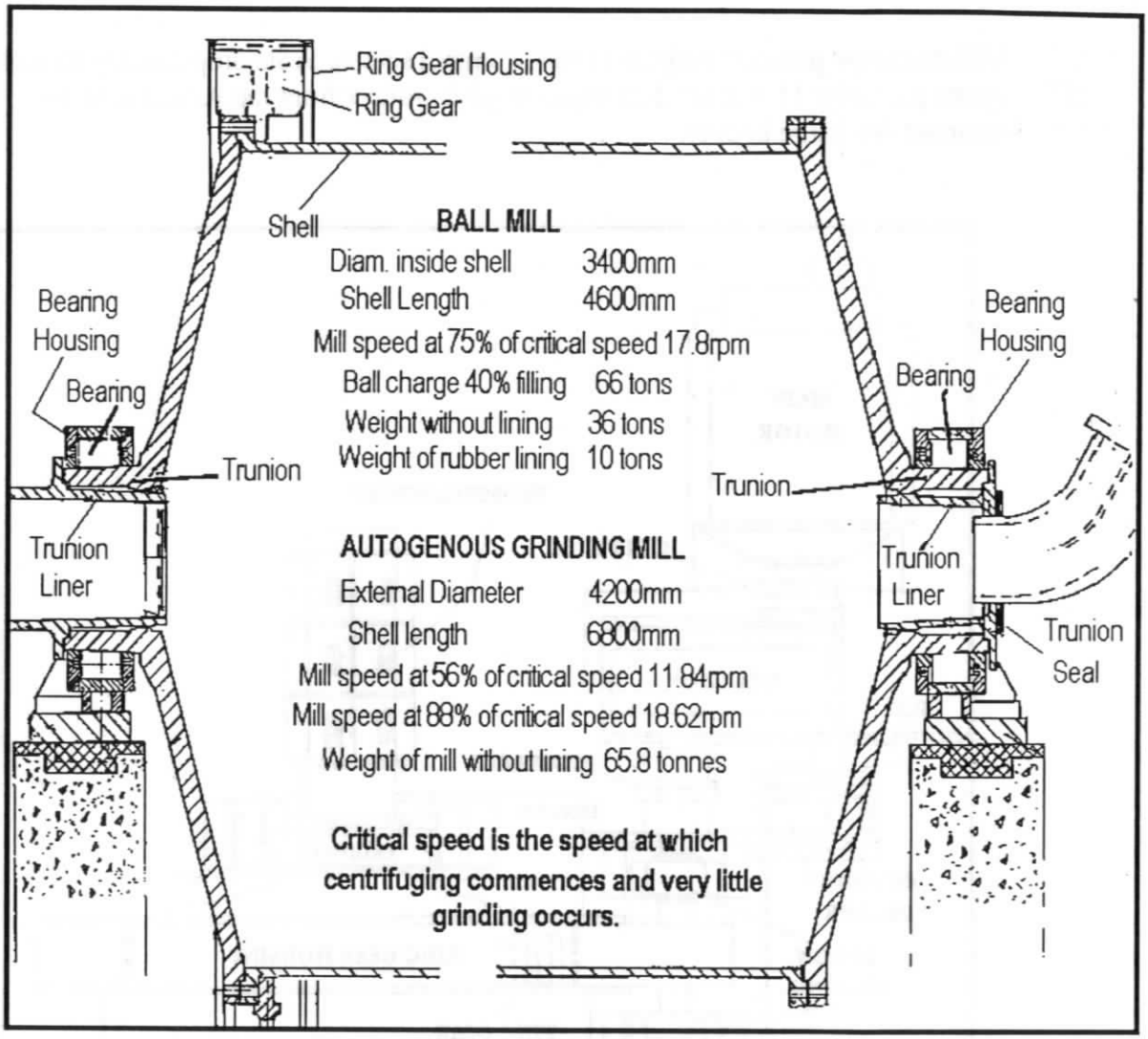


Figure 3.2 A mill shell

It is most important that when reporting faults that the operator is able to accurately describe the location of the problem. Operators should become familiar with the terms show in figures 3.1 and 3.2 above.

The Ball Mill

Under normal operating circumstances this mill is fed only by the underflow from the cyclones, but at times when the A. G. Mill is off line the mill may be fed from the fine ore bin, which has a live capacity of 2,500 tonnes. Ore from this bin passes through two cone activators on to CV5, the 600 mm wide variable speed feed conveyor, to the mill. The mill may also be passive fed via a Mexican hat feeder outside the bin.

100% of the feed would pass 13mm.

The ball mill, or regrind mill, is a Morgardshammar, rubber lined overflow discharge mill, 4.6 metres in length and 3.4 metres in diameter. It operates in closed circuit with a cluster of ten Hydrocyclones. It has an installed power of 840 kW and operates at a fixed speed of 17.6 rpm.

Mill discharge passes through a 11 mm trommel screen. Scats drop directly into a bin whilst the under 11 mm product mixes in with product from the A.G.Mill in the common discharge hopper.

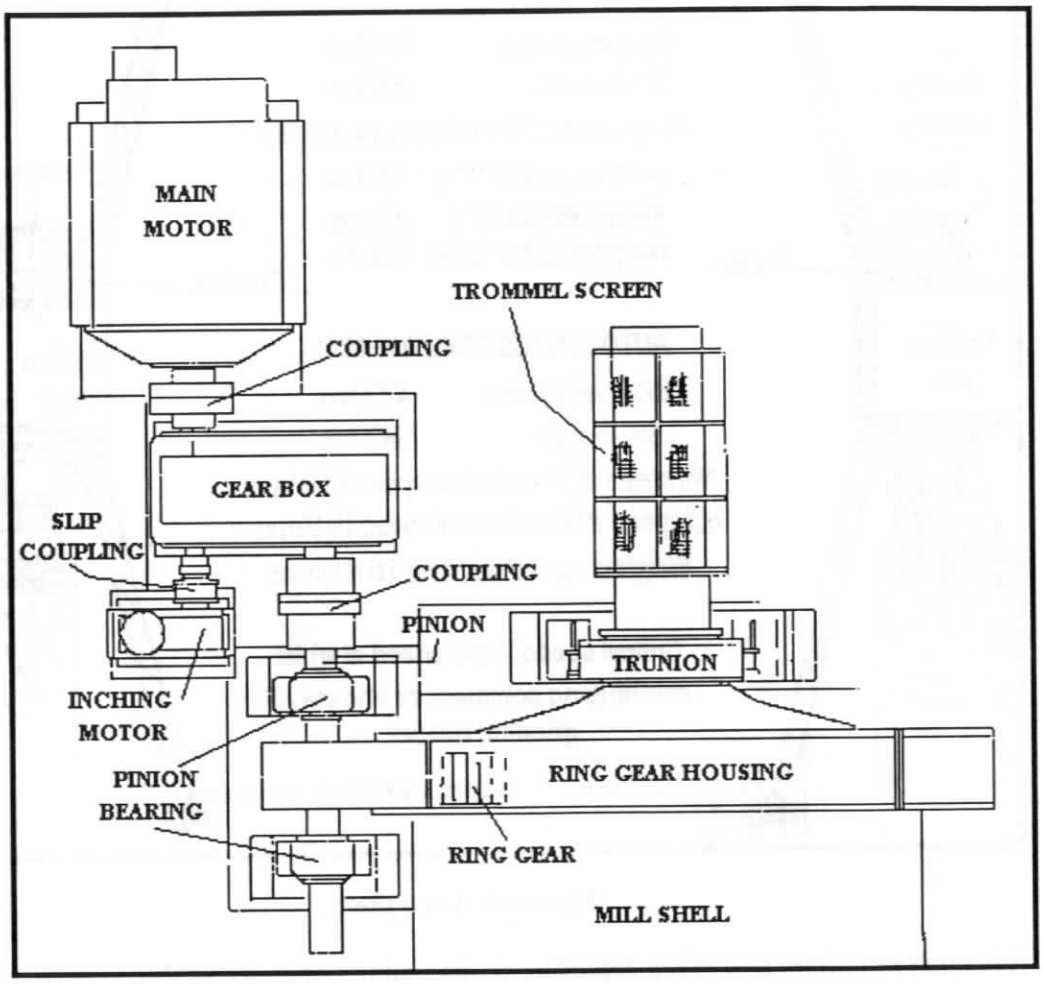


Figure 3.3 The Ball Mill drive arrangement.

The Cyclones

The mill product is pumped by a Warman 8-6 slurry pump to the cluster of ten Warman 250mm hydrocyclones. Cyclone overflow, normally around 42% solids with 80% passing 85 microns flows onto a trash screen which removes unwanted material and from there via a Warman 6-4 slurry pump to Leach tank No.1. The coarser underflow from the hydrocyclones passes back into the regrind mill which has a recirculating load averaging of between 250 and 350 percent.

The Scats Crushing Circuit.

Figure 3.4 shows the main element of our Jaques Gyrocone No.25 crusher. Again when reporting faults pin point the area by using the correct terminology.

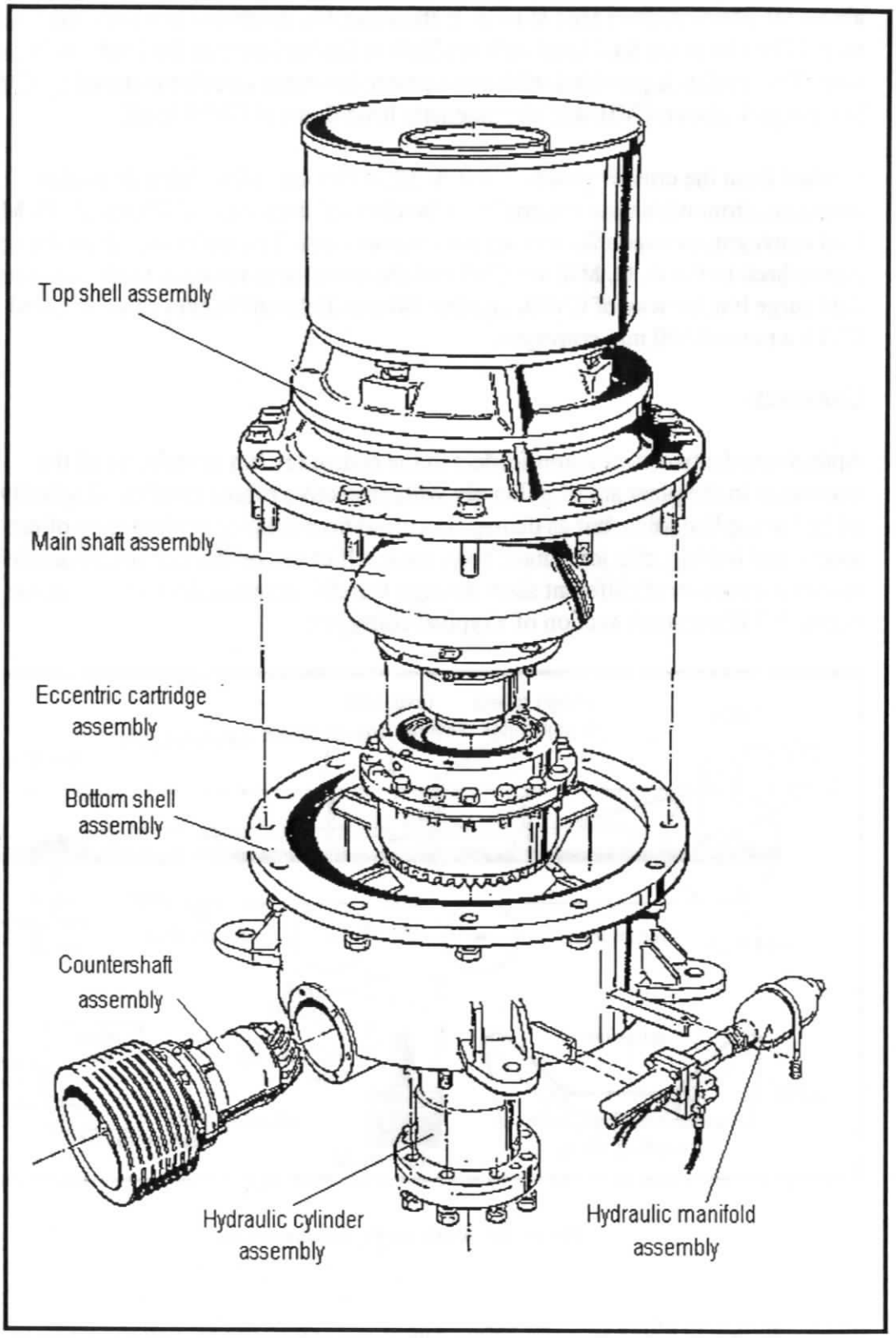


Figure 3. 4 Sections of the Scats Crusher.

Scats from the A. G. Mill pass on to CV10, a 500 mm wide conveyor, and from there to CV11, Beltwall bucket conveyor (740 mm wide with buckets 440 mm wide and 120 mm high) which feeds the scats up into the crusher feed surge bin. The Jaques Gyrocone No.25 crusher is fed by a vibrating feeder, the operation of which is controlled by both a sonic level controller in the surge bin and a high level earth strap above the actual crusher feed shroud. If the surge bin drops too low the feeder will stop. Likewise if the feed level gets too high in the feed shroud the feeder will also stop. The crusher is provided with some protection from metallic material by CV13 a belt magnet above CV10 and the magnetic head drum of CV10 itself.

Product from the crusher passes onto CV 12, a 740 mm wide Beltwall bucket conveyor, from which the material may be directed back on to CV9, the A. G. Mill feed conveyor, or over a 20 mm aperture screen deck. The under size from the screen passes back to the A. G. Mill via CV9 and the oversize is returned to the scats crusher feed surge bin, by way of CV15, another 740mm Beltwall bucket conveyor, and CV16 a normal 500 mm conveyor.

Conveyors

Apart from the two steel apron feeders in the coarse ore bin tunnels, all of the conveyors in the plant are of nylon ply with protective rubber coating. Originally they all had hot splice joins, but as damage occurred necessitating replacement of entire or sections of belting, clip joins have been used. All of the rubber conveyors are driven by electric motors of different sizes through belt drives and reduction gear boxes, Figure 3.5 illustrates a section of a typical conveyor.

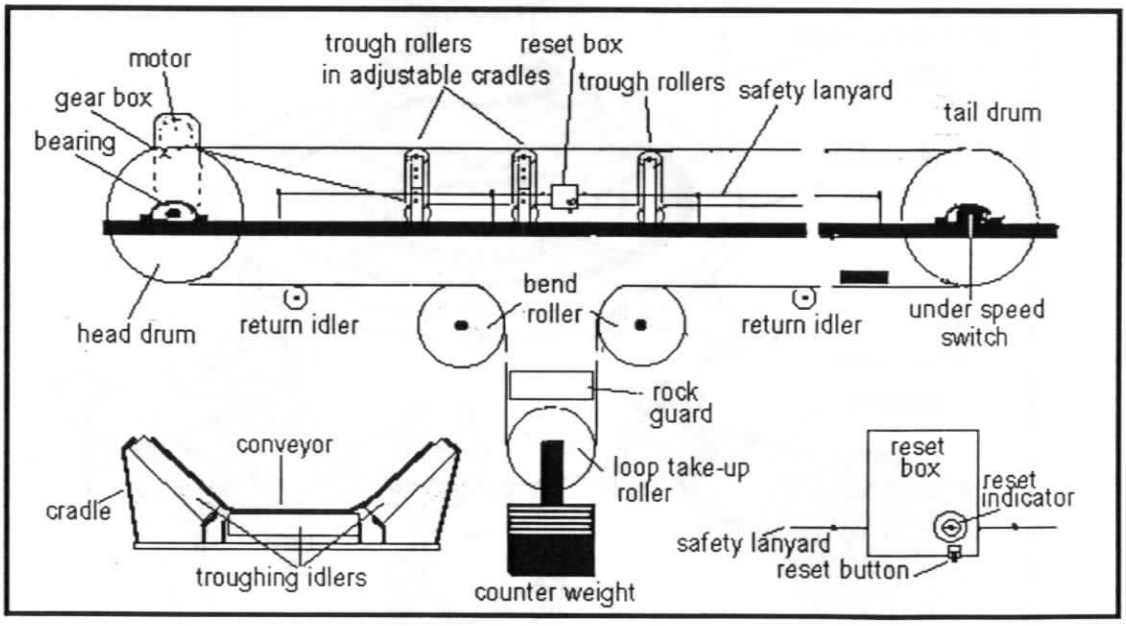


Figure 3.5 Sections of typical conveyor

All of the rollers idlers are removable. The single return idlers span the width of the conveyor whilst the troughing idlers are in sets of three as shown in figure 3.5.

Rubber skirts are attached to the sides of the feed chutes to prevent spillage over the side of the conveyor and deflector plates on each side at the head of the conveyor prevent spillage as the belt flattens out as it goes around the head drum.

The tail drum shaft has an under speed switch fitted to it. If the conveyor slows down or starts slipping on the head drum this switch will activate an alarm in the control room. CV5 also has belt drift detectors fitted along each side. If the conveyor should drift to one side and activate this switch, it will shut down.

All conveyors are fitted with safety lanyards on the sections that are accessible to workers. These are there for the protection of the worker and for emergency shutdowns should anything be seen to be wrong with the conveyor. Every lanyard has one or more reset boxes.

Safety

Never be tempted to jam the reset button so that it cannot be activated. It is tempting to do this when a conveyor is being constantly tripped by falling rocks. Regardless of this inconvenience it is a criminal act and could result in excessive damage to the conveyor or worse still the death or injury of a fellow worker.

Never leave guards off a conveyor. These are fitted at both the head and tail of each conveyor and on most return idlers where they are within reach.

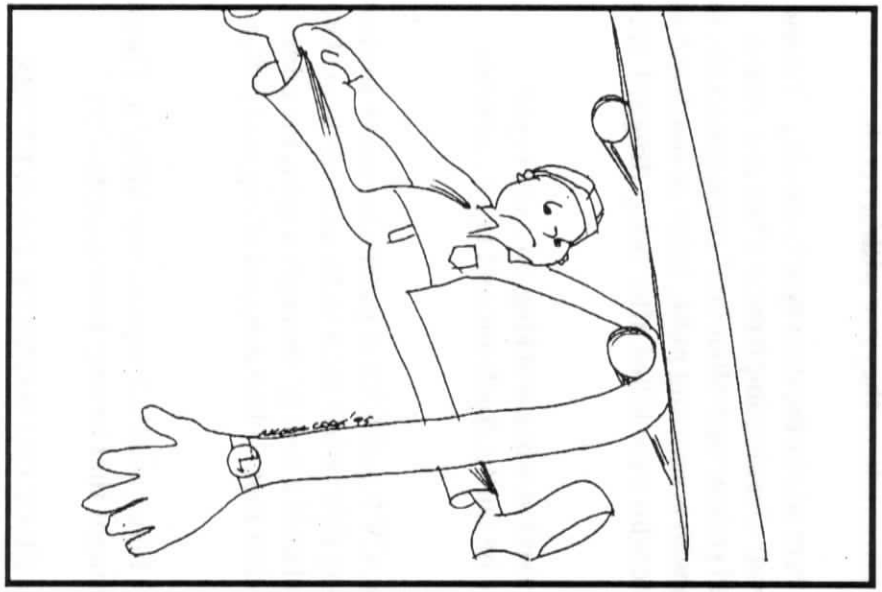
Never attempt to clean a idler or drum whilst the conveyor is moving. It is an instinctive reaction to hang on to your cleaning implement when it becomes entangled and that reaction has had serious and often fatal consequences in the past. The writer knows one person who is sporting pubic hairs on one hand after a skin graft and he knew two people who were killed after being dragged into head drums.

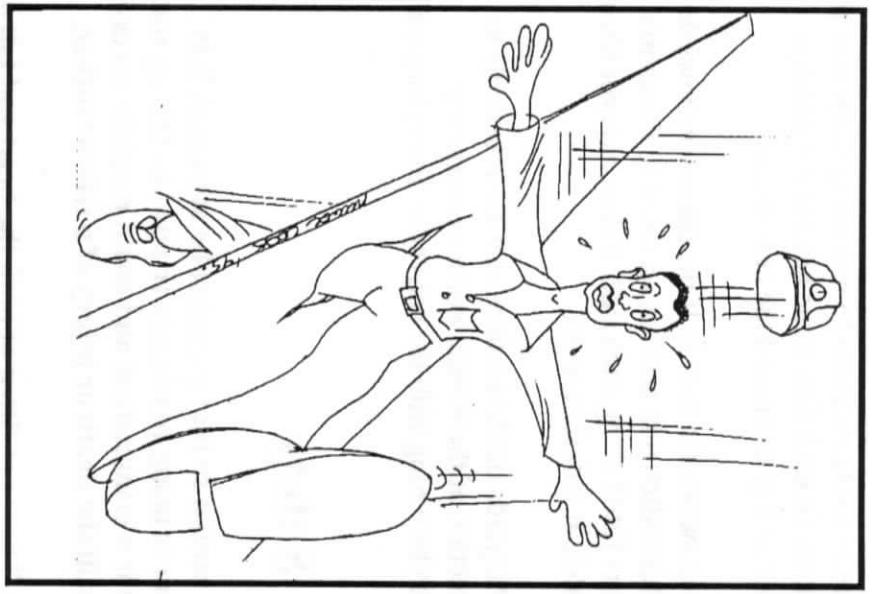
Never rely upon a trip wire for protection when working on a conveyor. Someone else may reset it or it may be faulty. Rack out and tag a conveyor before working on it.

Never step onto a moving conveyor. CV 7 and CV8 in particular move so slowly that one might be tempted into doing this rather than walk around them. The contour of a conveyor is such that should a foot go through a split, the odds are that the foolish person attached to that foot will be dragged along and suffer serious injury or death.

Never rest on a conveyor that `isn't being used'. A worker was killed at Finucane Island after doing just that. It is thought that he may have gone to sleep.

FOR THE CARELESS OR FOOLISH WORKER CONVEYORS CAN BE DEADLY





DON'T LET THIS BE YOU!

Pumps

The performance of the plant slurry pumps and water pumps is crucial to the successful operation of the plant. Figure 3.6 illustrates the main components of a typical Warman slurry pump used throughout the plant.

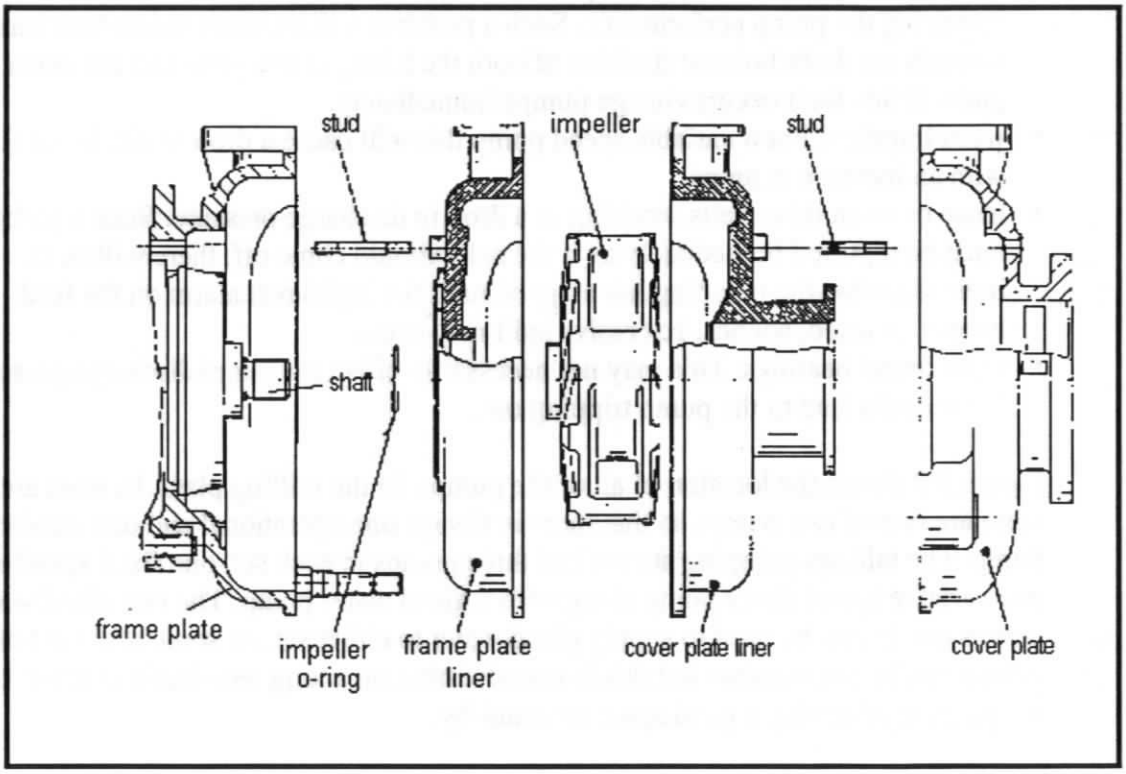


Figure 3.6 The main parts of a Warman slurry pump.

The main problems effecting performance are normally of a mechanical or operational nature.

Operational faults include:

- low feed hopper level resulting in air intake and the pump losing its prime.
- blocked suction pipe. If this is only partial the output will be reduced and the discharge pressure and amps will fall. This could cause rough running, vibration and cavitation.
- blocked impeller. Impellers are designed to handle certain product sizes. If particles are too big they may block the eye of the impeller, thereby restricting output. This could also a drop in discharge pressure and amps along with vibration.
- blocked discharge pipe. This may be caused by an abnormally high concentration of coarse particles in the discharge and or the velocity of the discharge being too low to adequately transport the solids. This problem would cause a rise in the discharge pressure and a drop in amps.

When shutting down pumps it is good practice to operate the pump on water for a short period before stopping it. Feed line valves should also be closed, especially if there are any solids remaining in the feed hopper and the pump should be scuttled.

Mechanical faults include:

- leaking shaft seal, this allowing intake of air and eventually may cause the pump to lose its prime.
- holed frame plate liner or cover plate liner, this allowing slurry to escape and impairing the pump performance. Such a problem will be made evident by leaking through the drain holes at the base of both the lifting frame plate and the cover plate. If this fault occurs change pumps immediately.
- worn impeller. For a variable speed pump this will cause a drop in discharge along with an increase in amps.
- loose or worn drive belts resulting in a drop in discharge pressure. Such a problem must be reported immediately as if the belts should come off, there will be no indication that the pumping has stopped until the high level alarm on the feed hopper, if fitted, sounds. Excessive spill may occur.
- worn barrel bearings. This may not necessarily effect the pump discharge pressure but it could lead to the pump tripping out.

Figure 3.7 shows the location of all of the pumps in the milling plant. In most areas there are sets of two pumps so that there is always one operational and one stand-by pump. The tailings pumping station has three pumps in each set, one fixed speed and one variable speed slurry pump along with a gland water pump. The two gland water pumps can in fact be used to supply gland water to either set. At some stations both pumps can be run together but this is not advisable on a long term basis as it forfeits the purpose of having a good spare on stand-by.

The tank circuit

Figure 3.7 displays all of the tanks, there being nine leach tanks and seven adsorption tanks. (L1 to L9 and A1 to A7 respectively). The first eight of the leach tanks each have an effective capacity of 575 m^3 whilst L9 and all of the adsorption tanks each have an effective capacity of 226 m^3. All of the tanks are fitted with Lightnin agitators, each having two sets of three blades. In the leach tanks the thrust of the agitators is directed downwards whilst in the adsorption tanks the top set of blades thrust upwards. Each of the adsorption tanks has a set of wiper blades fitted directly beneath the Kambalda screens. The adsorption tanks are configured differently so as to help prevent the screens from becoming blocked.

Tanks L1 to L9 also have low pressure air supply to the agitator shaft. Oxygen is, as explained later, vital to the leaching process. The low pressure compressor is located on the deck above leach tanks six and eight. In an emergency air from the high pressure compressors located on the west side of the power house, may be used. This is not good practice though as they are not designed for such use and can not supply sufficient air to service all of the leach tanks. In addition to this the heavy drain on the high pressure compressors plays havoc with the gold room air operated valves and the mill lube systems

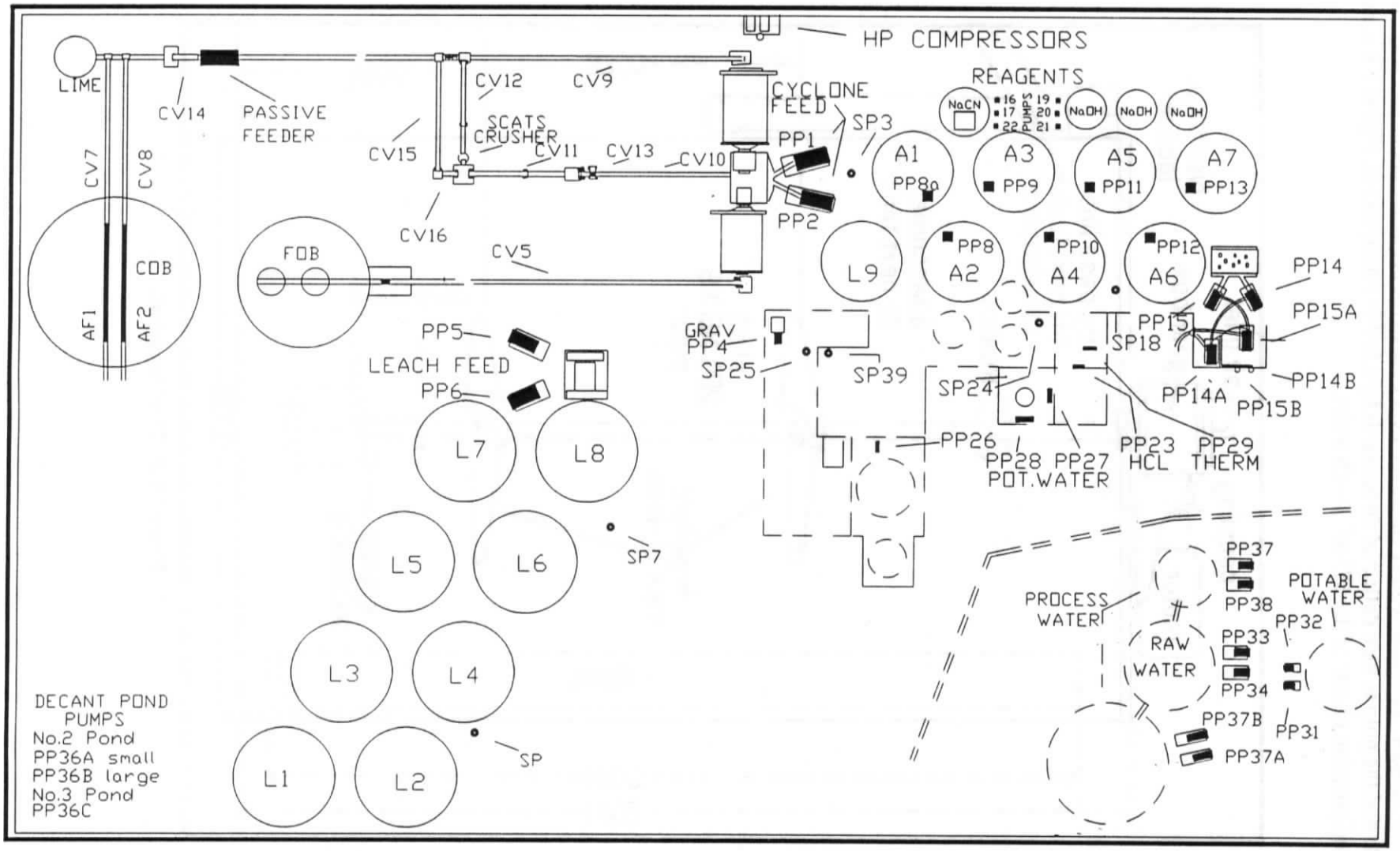


Figure 3.7 Plant layout

In the leach tanks normal flow between the tanks in sequence is via a downcomer from an overflow launder. This downcomer enters the next tank in the sequence about half way down its side and the pulp is then deflected downwards by a baffle arrangement. Figure 3.8 shows the configuration of one of the 575 m^3 leach tanks.

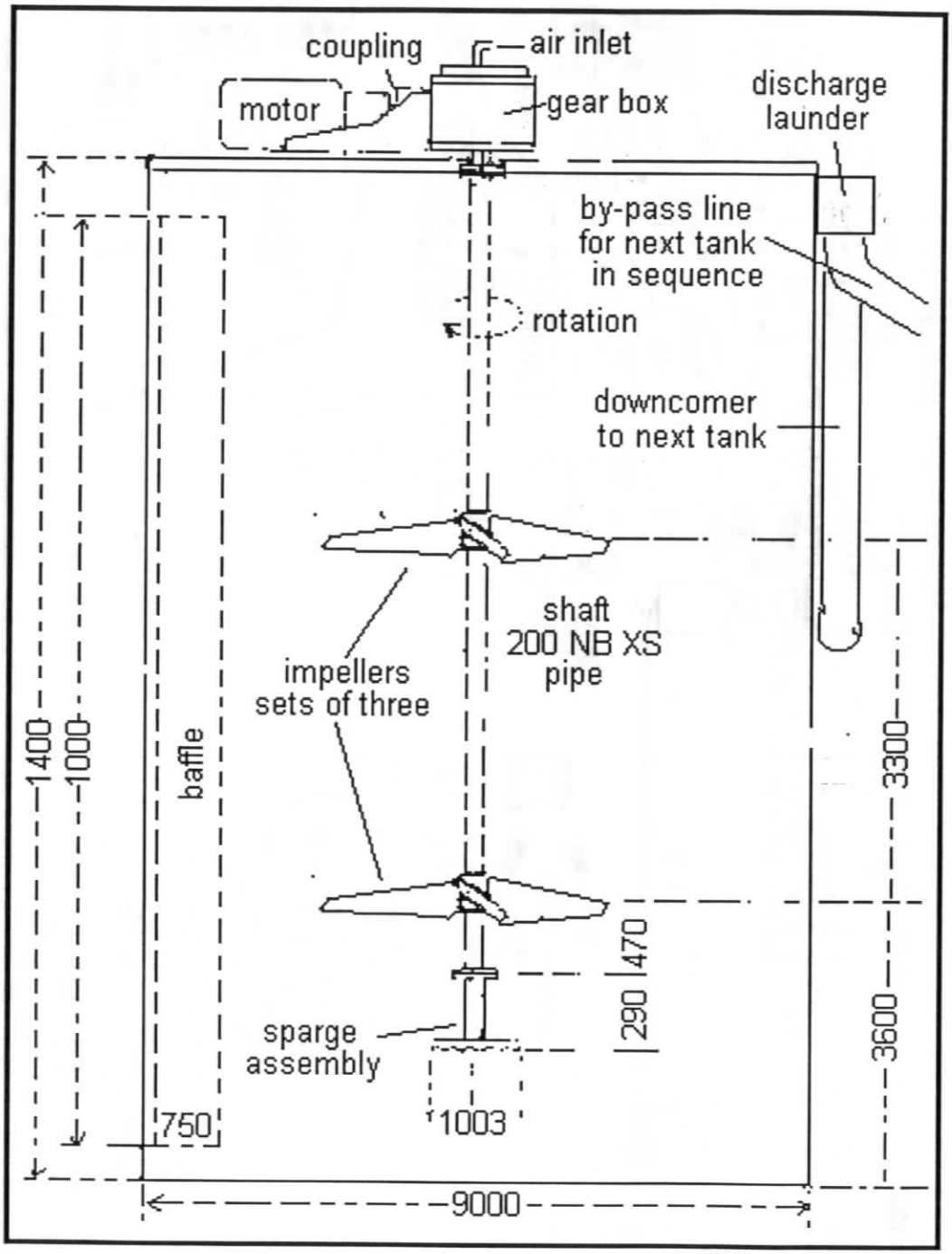
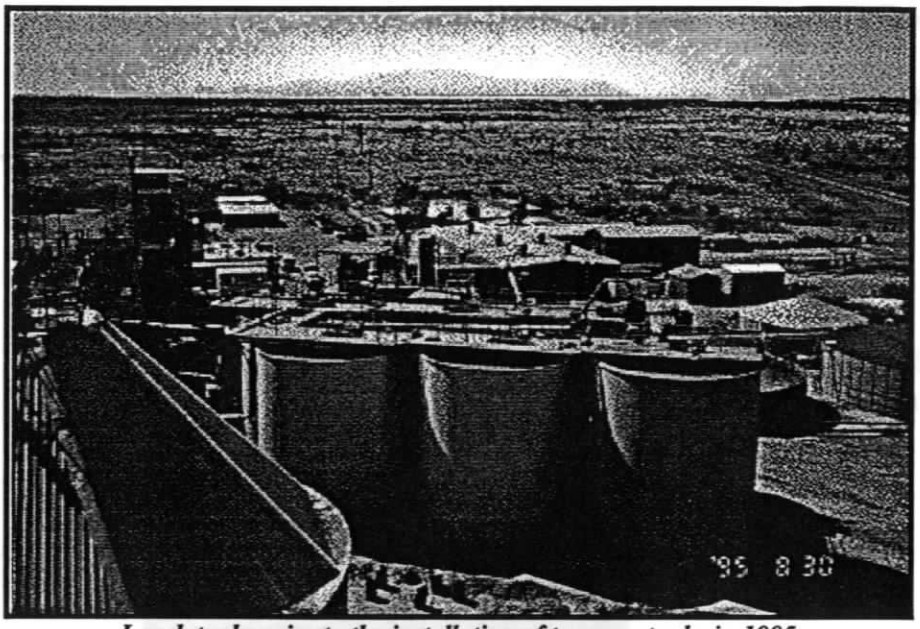


Figure 3.8 **A 575 m^3 leach tank.**



Leach tanks prior to the installation of two new tanks in 1995

Fig 3.9 shows the configuration for adsorption tanks A2 to A7. In these the pulp must flow up through the wedge wire in the base of the Kambalda screens and then pass down a down comer into the next tank in sequence.

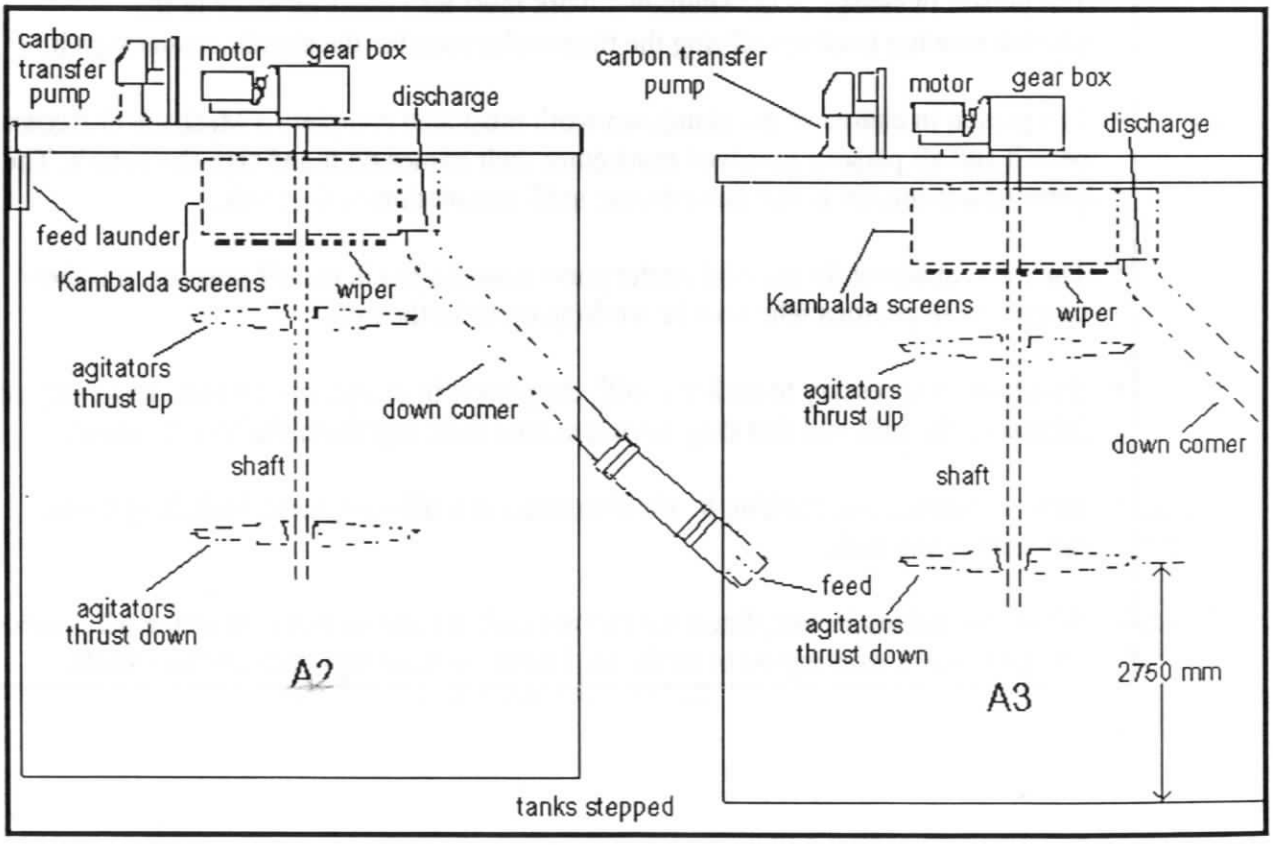


Figure 3.9 Adsorption tanks

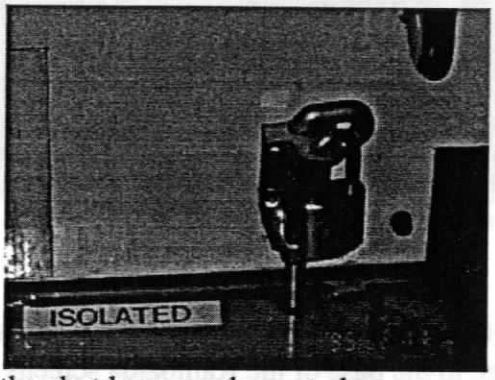
CHAPTER 4 MAJOR SHUTDOWNS AND STARTUPS

A: Shut down for maintenance - A. G. Mill only

SAFETY PROCEDURES

Autogenous Grinding Mill
Shut down for internal or external maintenance

- Electricians to rack out the relevant 3.3Kv breaker in the power house and then padlock it.



- The person in charge of the shutdown work must place a properly completed danger tag on the padlock.
- The person in charge of the shutdown work must also make an entry in the powerhouse log book specifying the time and reason for the shutdown and sign it.
- The person in charge of the shutdown work must also complete a Mechanical Access permit and all persons involved must enter their names on it and sign the permit. The permit must remain in the powerhouse until completion of the work.
- The lockout switch in the mill starter panel must be put in the off position and then tagged by all persons who will be working on or in the mill.
- Should it be necessary to inch the mill, the person in charge must ensure that everyone is clear of the mill and that they have removed their tags from the lockout switch.
- Before commencing inching he should ensure that all equipment, including hoses, are clear of the mill.
- When the inching is completed the lockout switch must be put back in the off position and all persons working on or in the mill must put their tags back on the switch.

A: Shut down for maintenance - A. G. Mill only (continued)

SAFETY
Conveyors - shutdown for maintenance.

- Isolating switch for conveyor to be racked out.
- All persons working on the conveyor must place a tag on the isolation tray switch.
- Depress the local stop button.
- Press the start button to ensure that the conveyor is in fact locked out.

1 If conveyors are to be run empty, set the AF1 and AF2 controller to manual mode and then stop both feeders.

2 Shut down CV9 when it runs empty ensuring that there is no feed from the scats crusher to CV9 beforehand. Accept low feed alarms as they come up.

3 Put feed on CV5 (40tph to start with)

4 Pull the gravity bung. This step is only necessary if the underflow density is allowed to get too low.

5 Adjust cyanide settings back; the lime addition will automatically stop when CV9 is stopped. Start caustic addition on a low setting.

6 Grind out to the required mill weight. Shut off water addition to the mill. Keep a close watch on the trommel discharge. If flushing is required turn the water back on for a short time. If work is to be done inside the mill, it is essential to flush out as much pulp as possible, leaving a clean bed of coarse material for people to walk on.

7 Turn off the feed water and trommel sprays; then at the local control station, (see figure 4.1 next page) select speed three and shut down the mill by doing the following:

- Stop the A.G. Mill motor.
- Stop the main gear box lube oil pump and cooler.
- Stop the auxiliary gear box lube oil pump and cooler.

8 If the mill is going to be off line for some time, shut down the scats crusher and associated conveyors using the group stop switch in the mill control room.

A: Shut down for maintenance - A. G. Mill only (continued)

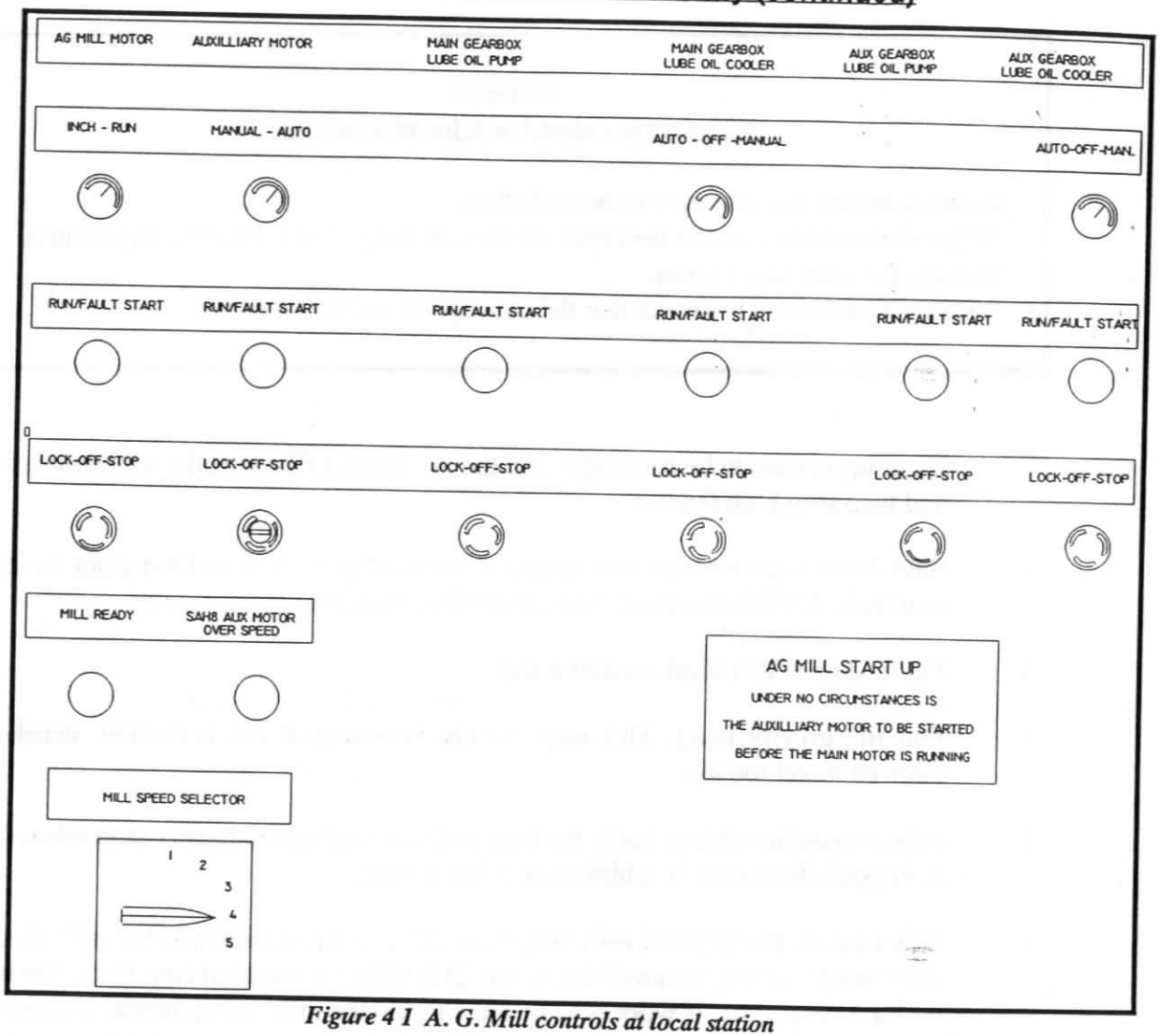


Figure 4 1 A. G. Mill controls at local station

9. Turn off the CV10 flushing water.

10 Shut down some of the cyclones so as to maintain a desirable cyclone feed pressure.

11 Try to maintain the cyclone overflow density at the previous operating density as this will help avoid surging through the tanks.

12 Replace the gravity bung when the mill circuit has settled down.

13. Increase fine ore feed if grind permits

14. Adjust the cyanide and lime (or caustic) addition as required.

B: Shut down for maintenance - ball mill only.

SAFETY PROCEDURES

Ball Mill

Shutdown for internal or external maintenance.

- Electricians to rack out the relevant 3.3Kv breaker in the power house and then padlock it.
- The person in charge of the shutdown work must place a properly completed danger tag on the lock.
- The person in charge of the shutdown work must also make an entry in the powerhouse log book specifying the time and reason for the shutdown and sign it.
- The person in charge of the shutdown work must also complete a Mechanical Access Permit and all persons involved must enter their names on it and sign the permit. The permit must be left in the powerhouse until completion of the work
- The main isolator switch outside the Motor Starter Room must be switched off and tagged by all persons involved in the work to be done.
- The inching gear must be engaged before commencement of any work.
- Should it be necessary to inch the mill, the person in charge must ensure that everyone is clear of the mill and that they have removed their tags from the main isolator switch. Before commencing inching he should ensure that all equipment including hoses, is clear of the mill.
- When the inching is completed the main isolator switch must be put back in the off position and all persons working on or in the mill must put their tags back on the switch.

1 Advise the gold room personnel in advance of the planned ball mill shut down.

2 Pull the gravity feed bung in the splitter box.

B: Shut down for maintenance - ball mill only (continued)

3 Get the gold room personnel to turn off all water addition to the gravity circuit.

4 Stop PP4 (gravity feed pump) and close the water addition valve.

5 Close the cyclone underflow valve so as to direct all under flow back to the A. G. Mill feed chute..

6 Cut back the A. G. Mill feed as found necessary. (Probably to around 80 tph)

7 Grind out the ball mill so as to achieve a clean discharge.

8 When the ball mill is sufficiently flushed out, shut off the water addition to the cyclone under flow box and any feed chute water. Wait for the mill discharge to cut back and then shut down the mill at the local control station (see figure 4.2) by pressing the stop switches for the following:

- Mill Motor
- Bearing Lube
- Gear Box Lube
- Gear Spray Lube

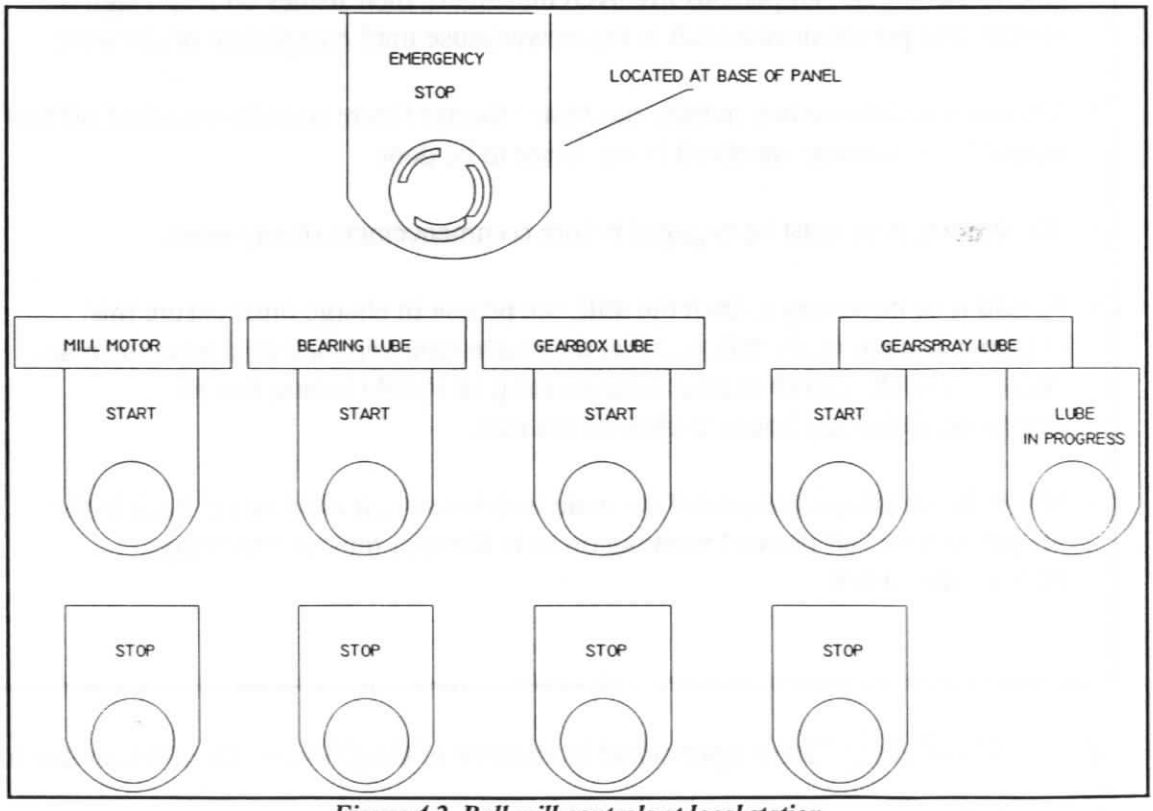


Figure 4 2 Ball mill controls at local station

B: Shut down for maintenance - ball mill only (continued)

9 Turn off the ball mill trommel sprays.

10 Turn off the ball mill gear box cooling water.

C: Shut down for maintenance - both mills

1 Advise the gold room personnel in advance of the planned ball mill shut down.

2 Steps A1 to A10 above but stop CV5 (if running) and shut off completely both the cyanide and (if being used) caustic addition pumps.

3 Get the gold room personnel to turn off all water addition to the gravity circuit.

4 Stop PP4 (gravity feed pump) and close the water addition valve.

5 Grind out the ball mill so as to a achieve a clean discharge.

6 If necessary close an additional cyclone in order to keep the cyclone pressure up as this will enable speedier grinding out.

7 Speed up the cyclone feed pumps (PP1 or PP2) so as to bring the mill discharge hopper level right down.

8 When the ball mill is sufficiently flushed out, shut off both the water addition to the cyclone under flow box and the make-up water to the mill discharge hopper. Wait for the mill discharge to cut back and then shut down the mill at the local control center (see figure 4.2 on page 30) by pressing the stop switches for the following:

- Mill Motor
- Bearing Lube
- Gear Box Lube
- Gear Spray Lube

9. Turn off the ball mill trommel sprays.

10 Turn off the ball mill gear box cooling water and all mill floor hoses

11 Turn off the mill discharge hopper valve and then scuttle the cyclone feed pump (PP1 or PP2).

C: Shut down for maintenance - both mills (continued)

12 Stop the mill area sump pump (SP3).

13 Shut down the trash screen and turn off the sprays.

14 Shut down the leach feed pump (PP5 or PP6) and then scuttle it

15 Turn off the gland valve water

16 Stop the two leach floor sump pumps.

17 Open up the process water addition valve to the tailings hopper so as to flush out the tailings line.

18 If for some reason it is necessary to shut down the tailings pumps, bung off tank A6 as soon as the discharge from it stops and ensure that are no hoses running on the leach or adsorption floors. Allow time for the tailings line to run clean and then shut off the process water addition to the tailings hopper.

19 Shut down the process water pumps if flushing water is no longer required for the tailings line.

20 Stop the tailings pumps PP14 and PP14A or PP15 and PP15A.

21 Stop the gland water pump PP14B or PP15B.

22 Whilst the plant is shut down, blow out all of the adsorption tank screens and replace all of the pump scuttle plates.

23 Monitor the level of the process water tanks during the shutdown as it may be necessary to shut off decant pond return water pumps.

D: Start up after maintenance - after a shut down of both mills.

(Assuming that the tailings pumps and the raw water pump are still running.)

SAFETY PROCEDURES

Both Mills - Start up Procedure

- The person in charge must ensure that all personnel are clear of the mill and that they have removed their danger tags.
- The inching gear must be dis-engaged (Ball Mill only)
- All personnel must then sign off the Mechanical Access permit.
- Should it occur that a person has left the mine site without removing his tag, his supervisor can only remove that person's tag, after he has ascertained that person's where-about. If he is still on site, he must remove his tag personally.
- The person in charge must sign off the Mechanical Access permit and complete a Cancellation of Permit docket.
- He should then remove his tag from the 3.3Kv breaker padlock.
- He should enter the time that he cancelled the Mechanical Access Permit and his signature in the Powerhouse log book.
- The electricians can then remove the padlock and rack the mill back in.
- Before starting the mill, the operator should ensure that all people and equipment are clear of the mill.
- A copy of the Mechanical Access Permit and the Cancellation Docket must be delivered to the Maintenance Superintendent's office.

D: Start up after maintenance - after a shut down of both mills (continued)

(Assuming that the tailings pumps and the raw water pump are still running.)

SAFETY

Conveyors - start up

- Ensure that all guards have been replaced.
- Ensure that all personnel have removed their tags.
- Rack the main isolating switch back in.
- Ensure that all people and their equipment are clear of the conveyor before starting it up.

1 Start the scats circuit in group mode from the mill control room.

2 Turn on the flushing water for CV10.

3 Open up the necessary number of cyclones for the desired feed rate.

4 Start up the trash screen and adjust the water sprays. Make sure that the screen by-pass valve is closed.

5 Start the leach feed pump (PP5 or PP6) and gland water.

6 Open the mill discharge hopper valve for whichever cyclone feed pump is to be used (PP1 or PP2)

7 Put the mill discharge hopper level controller on manual with the level set to about 4 bars. This prevents `seeking' with associated surging during start up.

8 If the gold room personnel are not available, mill personnel must also do the following:

- Start up the gold room sump pump.
- Start both Wilfley tables.
- Turn on the gravity water addition valve to the west of the landing below the gold room control panel.
- Switch on the concentrate pump for the ground floor Wilfley table.
- Turn on the water addition to the gravity feed pump and then start it.

D: Start up after maintenance - after a shut down of both mills (continued)

9 Start the cyclone feed pump. (PP1 or PP2)

10 Adjust the ball mill trommel spray.

11 Put the cooling water back on the ball mill gear box.

12 Put the feed water back on the cyclone under flow box.

13 Shut off the water addition to the tailings hopper

14. Start the ball mill at the local control station by doing the following:

- Ensure that the 110 volt system is turned on. The switch is located beneath the inching switch box outside the control station.
- Start the gearbox spray lube.
- Start the gear box lube.
- Start the bearing lube.
- Start the mill motor. (A siren should sound and the motor should step through three stages to achieve maximum power output.)

15 Turn on the process water pump.

16 Turn on the feed water and trommel sprays for the A.G.Mill. If the feed water controller is operational put it on manual.

17 Contact powerhouse personnel to ensure that enough engines are on line.

18 Make sure that the A.G.Mill is in speed three and then start up that mill at the local control station by doing the following:

- Ensure that all of the stop buttons are out (six in all)
- Ensure the A. G. mill motor is in Run position.
- Ensure that the Auxiliary motor is in Auto position.
- Ensure that the Main Gearbox lube oil cooler is in Manual position.
- Ensure that The Auxiliary Gearbox lube oil cooler is in Manual position.
- Start the Auxiliary gearbox lube oil pump.
- Start the Auxiliary gearbox lube oil cooler.
- Start the Main gearbox lube oil cooler.
- Start the Main gearbox lube oil cooler.

(A *Mill Ready* light should come on.)

D: Start up after maintenance - after a shut down of both mills (continued)

- Press the A. G. Mill motor start button - a siren will start and the mill motor will go through seven stages before it reaches maximum power output.
- When the A. G. Mill has reached maximum power start the Auxiliary motor.
- Select the desired speed.

19 Start CV9

20 Start the cyanide and lime addition

21 Put the apron feeders on manual control and start them on 25% to get the system going.

22 If requested by the gold room personnel, turn on the water addition to the gravity feed pump (PP4) and start that pump.

23 Turn on the sprays for the DSM screen and then put in the bung in the cyclone under flow splitter box.

24 If the start up is after hours the gold room personnel will need to be called out so that they can adjust the split on the Wilfley tables.

25 Adjust feed and water addition to both mills until they have settled down.

26 When the mills have settled down, put the controller for water addition to the mill feed chute back in auto.

27 Put the apron feeders on to auto control.

28 Keep a close watch on the tanks to ensure that there are no blockages.

29 When the milling circuit has completely settled down advise the gold room personnel.

30 Start the decant pond pumps if necessary

31 Check the tailings line to the dam.

E: Procedure for when there is a complete power failure.

1 Pull the bung out of the cyclone under flow splitter box.

2 Turn off the DSM screen water sprays.

3 If the power failure is at night call out the gold room staff so that they may switch on the electrowinning cell rectifiers and electrowinning pump when power becomes available.

4 When sufficient power becomes available start up the potable and raw water pumps.

5 Start up the trash screen and adjust the water sprays. Make sure that the screen by-pass valve is closed.

6 Start the leach feed pump (PP5 or PP6) and turn on gland water.

7 Open the mill discharge hopper valve for whichever cyclone feed pump is to be used (PP1 or PP2)

8 Put the mill discharge hopper level controller on manual with the level set to about 4 bars.

9 If the gold room personnel are not available, mill personnel must also do the following (all controls are accessible from outside the gold room.):

- Start up the gold room sump pump.
- Start both Wilfley tables.
- Turn on the gravity water addition valve to the west of the landing below the gold room control panel.
- Switch on the concentrate pump for the ground floor Wilfley table.
- Turn on the water addition to the gravity feed pump and then start it.

10 Put the tailings hopper level controller on manual and reset to the level operating at prior to the power failure.

11 Start up the tailings pumps. First make sure that the scuttle plates are in place and that the gland water pump is running.

12 Start up the tailings screen and adjust the water sprays.

13 Start up all of the tank agitators - L1 to L8 from the MCC and L9 to A7 at the local stations.

E: Procedure for when there is a complete power failure (continued)

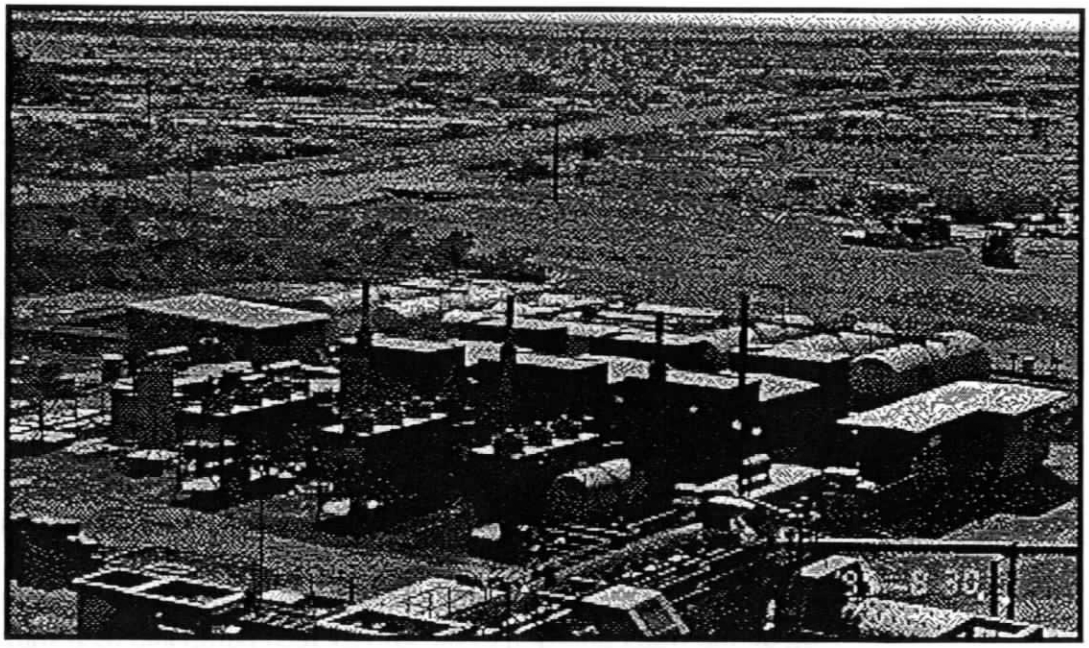
14 Start up both the high and low pressure compressors.

15 As per steps D9 to D28 above.

16 If the regeneration kiln was operating prior to the shut down, it should also be started again.

17 Maintenance may also need to start up the R.O. plant.

18 Start the decant return water pumps.



The powerhouse prior to expansion in 1995

F: Fault finding

If equipment fails to start or if it shuts down unexpectedly it is important that all operators know what to look for in order to fix the problem. Many of these problems may be avoided by the carrying out of proper pre-start checks of equipment. Operators should become familiar with all of the items listed in this section and should make sure that the all possible causes of a problem have been checked out before calling on maintenance for assistance.

1. Conveyors

Ready light not on in the control centre. Check the following:

- Power - is the item racked in.
- Local stop buttons - should all be out.
- Stop buttons in control centres - should all be out.
- Safety lanyards for trips - pull and reset to be sure.
- Overloads - check for the cause before resetting these. After three attempted starts in an hour get help from the electricians.
- Under speed switch - if the conveyor is slipping or the drive belts are loose this switch will be activated.
- Drift switch (CV5 only) - rocks jammed in rollers, build up in chutes or dirt under the counterweight may cause the conveyor to drift.
- Local stop/start buttons may be faulty due to contact with dust or moisture. Always get these checked out immediately.

The ready light is on but the conveyor will not start. Check the following:

- Interlock - CV7 and CV8 will not start unless CV9 is going. If it is necessary to start these conveyors only switch them to manual and start from the local station. Avoid running conveyors on manual when they should be in group sequence. This practice can lead to spillage and damage to equipment.
- Interlock - AF1 and AF2 will not go unless CV7 and CV8 are operating.
- Interlock - CV5 and CV9 will not go unless there is sufficient process water pressure. Unless these interlocks are bypassed.

Operators should regularly check for the following:

- Loose or missing drive belts.
- Spillage - under the counterweight and along the side of the conveyor. This may trip the safety lanyard or cause drifting of the conveyor.
- Blockage in feed chutes.

F: Fault finding (continued)

2: Pumps

Ready light not on - check for the following:

- Pump racked out - no power.
- Local stop/start button in. Should be out.
- Overload - check for the cause before resetting.. After a maximum of three starts in an hour call out the electricians.

Ready light on but pump will not start - check the following:

- Interlock - PP1 or PP2 will not start unless PP5 or PP6 is going. Do not attempt to overcome this problem by starting either pump in manual.

Pumps start but will not pump. Check for the following:

- Blocked or bogged. - check the feed hopper and if necessary disconnect the discharge line and try the pump.
- Drive belts slipping or broken. Change pumps and get maintenance to fix the problem.
- Valves not open - very naughty.
- Cavitating - try increasing the feed.
- No feed - process water tank has a low level alarm
- 110V controller faulty - get electricians to reset it. This may occur after power failures. The pump registers as running but has no speed control.
- Discharge lines may be holed - eg a carbon pump may be going but the discharge may be escaping under the pulp.
- Impeller may be worn - made evident by a gradual decline in performance.

Operators should check regularly for the following:

- Loose or missing drive belts.
- Leakage from the cover plate holes or the seals.
- Worn feed and discharge lines.

F: Fault finding (continued)

3. Start up problems - things to ensure.

- The powerhouse is ready.
- The scats circuit must be going prior to trying to start the mills.
- All pumps must be going prior to starting the mills.
  - ⇒ If there is no raw water the leach feed pumps and the tails pumps cannot be run.
  - ⇒ The gold room will not be able to operate without raw water.
  - ⇒ If there is no process water the A. G. Mill cannot be started.

- All of the Kent and Foxboro controllers are ok before starting the mills. It is no good starting the mills if the pumps (PP1 and 2, PP5 and 6, PP14 and 15, etc.) and the feed conveyors (AF1 and 2) cannot be controlled. The controllers often play up after a power failure.

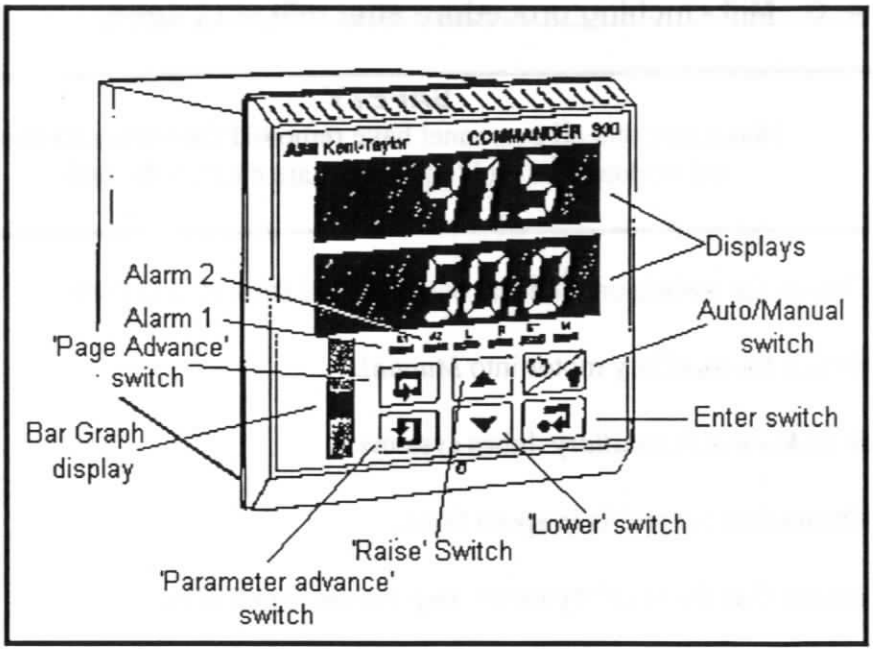


Figure 4.3 Kent -Taylor 'Commander' Controller

The normal indication that something has gone wrong with a controller is that the displays will either be blank or will be flashing an obviously incorrect figure. By pressing the auto/manual switch to select manual, the operator can by using the raise and lower switches, increase or lower the factor being controlled, eg level in a pump feed hopper. He can also use the parameter advance switch to select the upper or lower limit for a particular factor such as hopper level, which he can then alter by pressing the raise or lower switches.

CHAPTER 5 THE GRINDING CIRCUIT - BASIC OPERATIONS

A: A. G Mill - changing speeds.

1 After the initial start up the mill will be in speed three with the auxiliary motor ready.

2 To change to speeds two or four, move the *Speed Selector* switch to the desired speed and the siren will sound to indicate auxiliary motor start up. Observe the gear change.

3 To change more than one speed, select the next applicable speed and wait for the mill to change into that speed, before selecting the next speed. Hence if going from speed four to speed two, select speed three and wait for the actual change to that speed. Then select speed two. Likewise if going from speed two to speed four, select speed three and wait for the change, then select speed four.

B: A. G. Mill - inching procedure after mill shut down.

> ***SAFETY***
> Make sure that all personnel have removed their tags and that all workers and their equipment are clear of the mill.

1 Change the switch on the local control panel from *Run* to *Inch.*

2 Switch the auxiliary motor into *Manual.*

3 Start *Main* and *Auxiliary* lubes systems..

4 Ensure that the mill is in speed three.

5 Ensure that the auxiliary motor *Stop* button is pulled out.

6 Start the auxiliary motor.

7 For slow clockwise rotation select speed four.

8 For fast clockwise rotation select speed five.

9 For slow anti-clockwise rotation select speed two.

10 For fast anti-clockwise rotation select speed one

11 When the mill is in the desired position press the auxiliary motor Stop button.

12 Stop both lube systems.

C: Ball Mill - inching procedure after mill shut down.

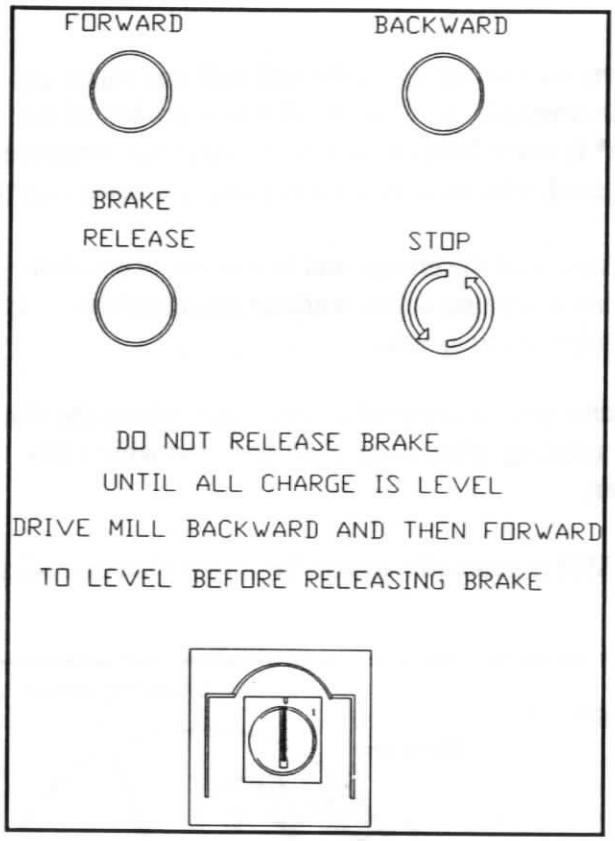


Figure 5.1 Ball mill inching controls

SAFETY

Make sure that all personnel have removed their tags and that all workers and their equipment are clear of the mill.

1 Switch off the 110 volt power supply.

2 Have maintenance shift the coupling across so that the inching motor is engaged with the ball mill gear box.

3 If work is to be done inside the mill, it will need to be turned so that the manhole is on top. Make sure that the *Stop* button is out and then press the *Brake Release* button and use the *Forward* or *Backward* buttons to get the mill into the correct position. Make sure that the load inside is horizontal position before stopping the mill. This could necessitate taking the mill past the desired position and then back again in order to shift the load into the horizontal.

4 Press the *Brake Release* button. If the load in the mill is not completely horizontal, the mill may rock a little.

5. Push in the *Stop* button and then switch off the *Isolating* switch below

D: The effect of changes in speed of rotation on grinding

The speed at which a mill is run is important, since it governs the nature of the product and the amount of wear on the shell liners. Due to the rotation and friction of the mill shell, the grinding medium is lifted along the rising side of a mill until a position of dynamic equilibrium is reached, where the bodies cascade and cataract down the free surface of the other bodies, about the dead zone where little movement occurs, down to the toe of the mill charge.

At lower speeds, or with smooth liners, the medium (balls in the ball mill and relatively coarse, harder rock in the autogenous grinding mill) tends to roll down to the toe of the charge. In this instance the comminution* is essentially by way of a cascading, abrasive action and the net result tends to a finer grind, with increased slimes and increased liner wear.

At higher speeds the medium is projected clear of the charge and in a series of parabolic arcs, finally lands on the toe of the charge. This cataracting action leads to comminution by impact and results in a coarser end product with reduced liner wear.

If the mill speed is increased further the charge will eventually centrifuge, where the charge is held against the mill shell and very little grinding takes place. The speed at which this commences is known as the ***critical speed***.

The maximum speed on an Autogenous Mill is generally around 80-85% of the critical speed, with a 35-40% load volume.

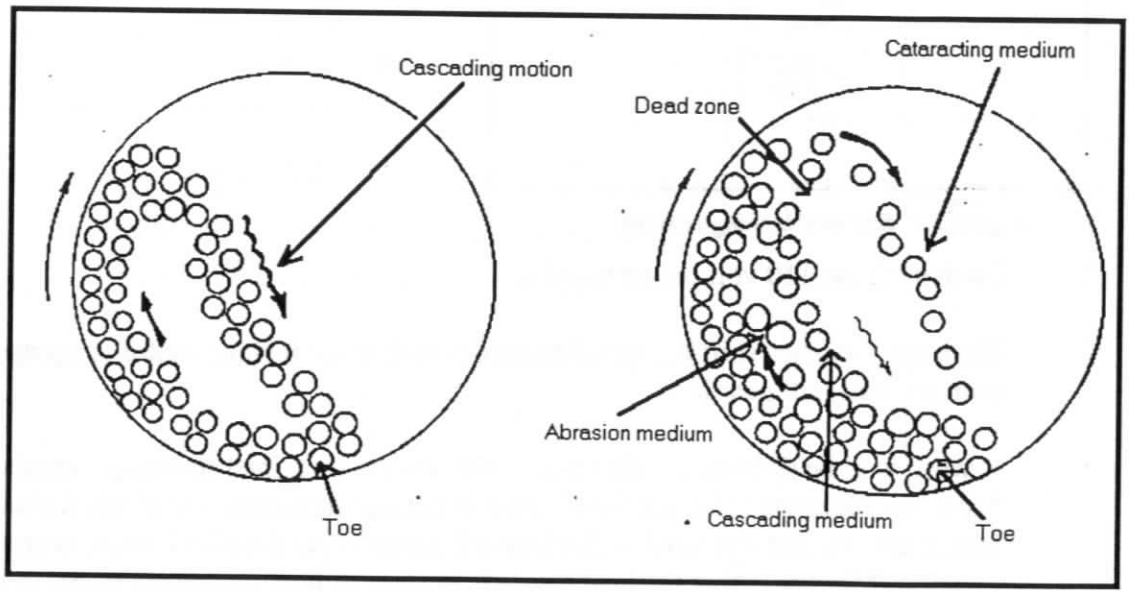


Figure 5.2 Motion of charge in ball mill
(Courtesy of W.A. School of Mines)

**Comminution involves both crushing and, if necessary grinding, to a particle size which ensures that the product is a mixture of relatively clean particles of mineral and waste (gangue) material ready for the later separation processes.*

E: Useful operational hints for Ball Mills

The following problems, causes and adjustments are given as a means to help operators become more efficient ball mill operators. Some of the problems relate also to our autogenous mill. The three adjustments that a mill operators can control throughout each shift to keep a grinding circuit in balance are (1) the feed rate, (2) the mill feed water and (3) the water to the cyclones (mill discharge hopper addition water). As the character of the feed material changes, these controls must be adjusted, and generally two or more changed simultaneously to maintain a good grind.

Problem	Cause	Adjustment to be made
Mill discharge too coarse	Tougher and/or coarser feed. Too low pulp density . Too much feed - trouble ahead. Ball mill charge wearing down.	Watch for power changes. Cut down on feed and feed water. Decrease feed water. Cut down on feed. Add balls.
Mill discharge too fine.	Softer and/or finer feed. Too high pulp density. Too little feed	Increase feed and feed water. Increase feed water. Increase feed.
Decreasing mill capacity	Tougher and/or coarser feed Ball charge wearing down. Ball charge too high. Too low solids. Too high solids. Mill recently re-lined. Blocked grate or trunnion.	May need more feed water. Add more balls. Decrease the ball charge rate. Cut down the feed water. Increase the feed water. None - to be expected. Shut off feed and grind out or shut down mill and clear grates or trunnion.
Ball and/or liner wear increased.	More abrasive feed. Under-loaded mill. Too low solids.	No adjustment to improve wear. Increase feed. Decrease feed water.
Balls purged from mill.	Too high feed rate. Too high pulp density.	Reduce feed. Increase feed water.
Too high circulating load.	Too much feed. Tougher and/ or coarser feed. Too low pulp density.	Decrease feed. Reduce feed and feed water. Reduce water.
Ball mill motor ammeter shows power dropping.(no change in feed characteristics involved)	Mill over-loading. If change very slow could indicate ball charge reduction.	Cut down on feed and feed water. Add balls.
Ball mill motor ammeter shows power rising.(no change in feed characteristics involved)	Mechanical problem	Inspect for lubrication and mechanical damage.
Balls breaking or spalling.	Balls too brittle.	Contact Mill Superintendent.
Mill sound - loud metallic rattle.	Mill under-loaded . Too low solids.	Increase feed rate. Decrease water in feed.
Mill sound - muffled, mushy.	Mill over-loaded - trouble.	Decrease feed rate.
Feed spillage.	Tougher and/or coarser feed. More feed water needed. Grates blocked (A.G.Mill)	Decrease feed. Increase feed water. Shut down and clean grates.

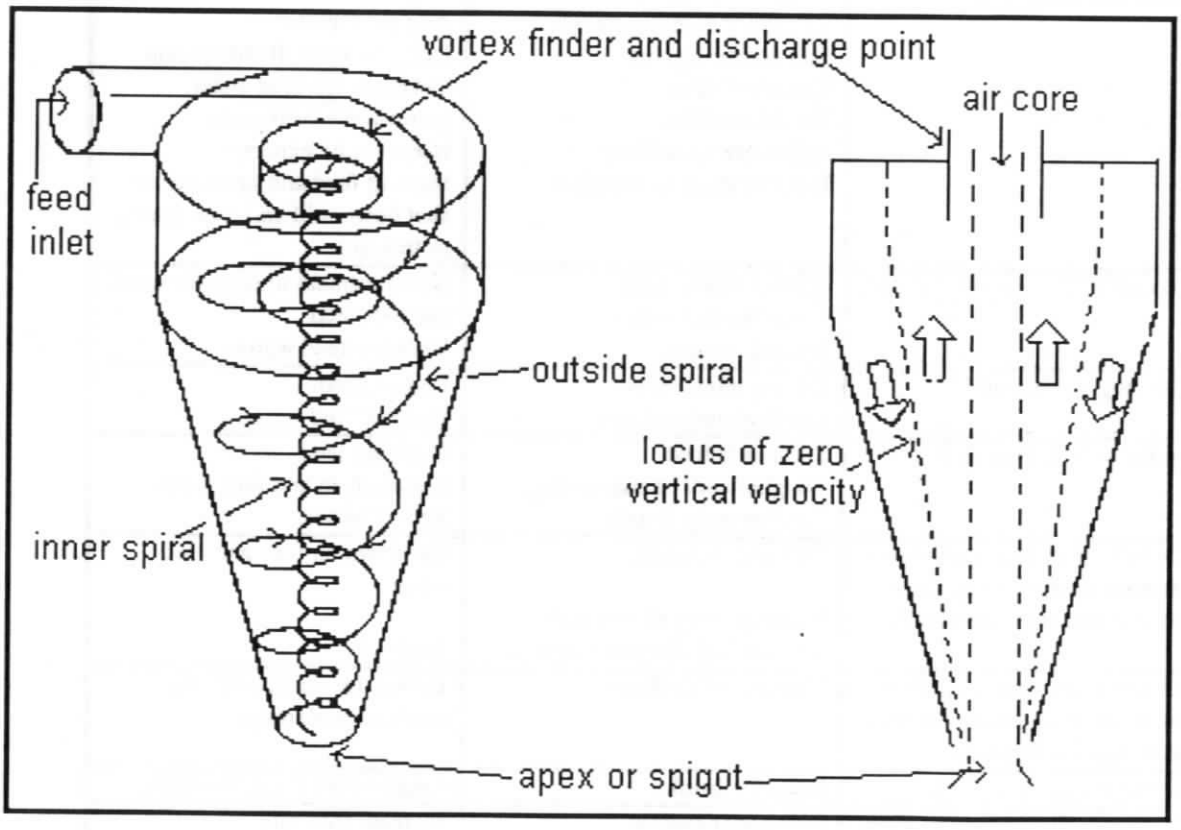
Table 5.1 Ball mills - problems and how to overcome them

F: Hydrocyclones - factors effecting their performance.

A particle in the pulp stream is subjected to two opposing forces within a cyclone.

a) outward centrifugal force, and
b) inwards drag forces.

The centrifugal force accelerates the settling rate of the particles on the basis of size and specific gravity. The large dense particles which settle fastest, move to the cyclone wall where the velocity is a minimum, and they move to the apex or spigot opening. The smaller particles which are slower settling, move towards the zone of low pressure along the axis, due to the influence of the drag forces. The particles in the central region are then carried upwards and are extracted by the vortex finder into the cyclone overflow. In figure 5.3 the drag forces are illustrated in the RHS diagram and the centrifugal forces in the LHS diagram.



Fiure 5.3 Hydrocyclone
(Courtesy W.A.School of Mines, 1988
and redrawn by Craig Harris)

Factors affecting the performance of a cyclone are:

a) The operating pressure
b) The Vortex Finder diameter
c) The solids content of the pulp
d) The size of the spigot
e) The size and shape of the inlet port

The first three factors are the most important variables, whilst the size of the spigot has a lesser influence and the inlet port dimensions are generally fixed.

If the other factors are kept constant and increase in feed rate with a corresponding increase in pressure, will result in an increased pressure drop within a cyclone. This increases the centrifugal force effect and results in more finer particles from the upper range being carried to the underflow, ie. the overflow becomes finer.

At a given pressure drop across a cyclone an increase in the diameter of the vortex finder will result in a coarser overflow.

Increasing pulp density may result in an increase the degree of hindered settling and this will result in a reduction in the effective pressure drop across a cyclone. Separating out (classification) of the finer sizes and the cyclone efficiency will be impaired.

The size of the spigot or apex is one of the factors determining the underflow density. Other factors remaining constant, if the size of the spigot is increased, the underflow density will decrease. Unclassified material leaves the underflow in proportion to the fraction of feed water leaving via the underflow. Cyclones operate most effectively when the underflow density is kept as high as possible. The size of the spigot must however be large enough to allow the discharge of coarse solids separating out and also the formation of the air core.

Too small a spigot opening can cause 'roping', ie. the discharge becomes a thick pulp stream the same diameter as the spigot. This may result in loss of the air core and separation efficiency will fall with more oversize material discharging via the vortex finder.

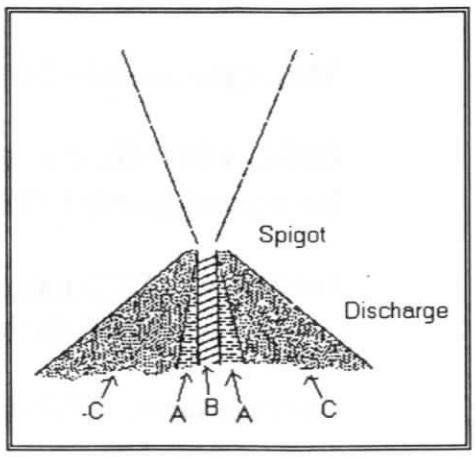


Figure 5.4 Effect of spigot size in cyclone underflow:

A - Correct operation.
B - Roping - spigot too small.
C - Too dilute - spigot too large.

G: Weightometer Calibration Checks - CV5

(Must not be done during windy conditions)

1 Items required to do a weightometer calibration check

- a stop watch
- a one metre belt cutter
- two 20 litre buckets with lids and tare weight written on the side
- paper and pen
- small broom and dust pan
- measuring tape
- white paint (spray can)

2 Warn the mill operator that you will be doing calibration checks on the conveyor.

3 Stop CV5 and measure a 30 metre section. Mark with paint the starting and finishing points. Then start the conveyor and time how long it takes the 30 metres to pass (Three times to get a proper average).

4 Wait for the feed on the conveyor to steady and then record the tonnes per hour from the Kent controller in the mill control room. Then stop the conveyor.

5 Push the one metre sample cutter down through the ore on the conveyor. Use the broom and dust pan to transfer all of the coarse ore and fines from the one metre section to a bucket. Put a lid on the bucket to prevent accidental spillage. Get another one metre sample from another section of the conveyor.

6 Go to the Laboratory and weigh the samples, remembering to subtract the tare weight. Note the weights. (34338.1 and 344692.0 grams in this example)

Calculation of error factor

30 metres length in 85.58 seconds (an average of three measurements).
The indicated tph was 40.9 (from The Kent controller).

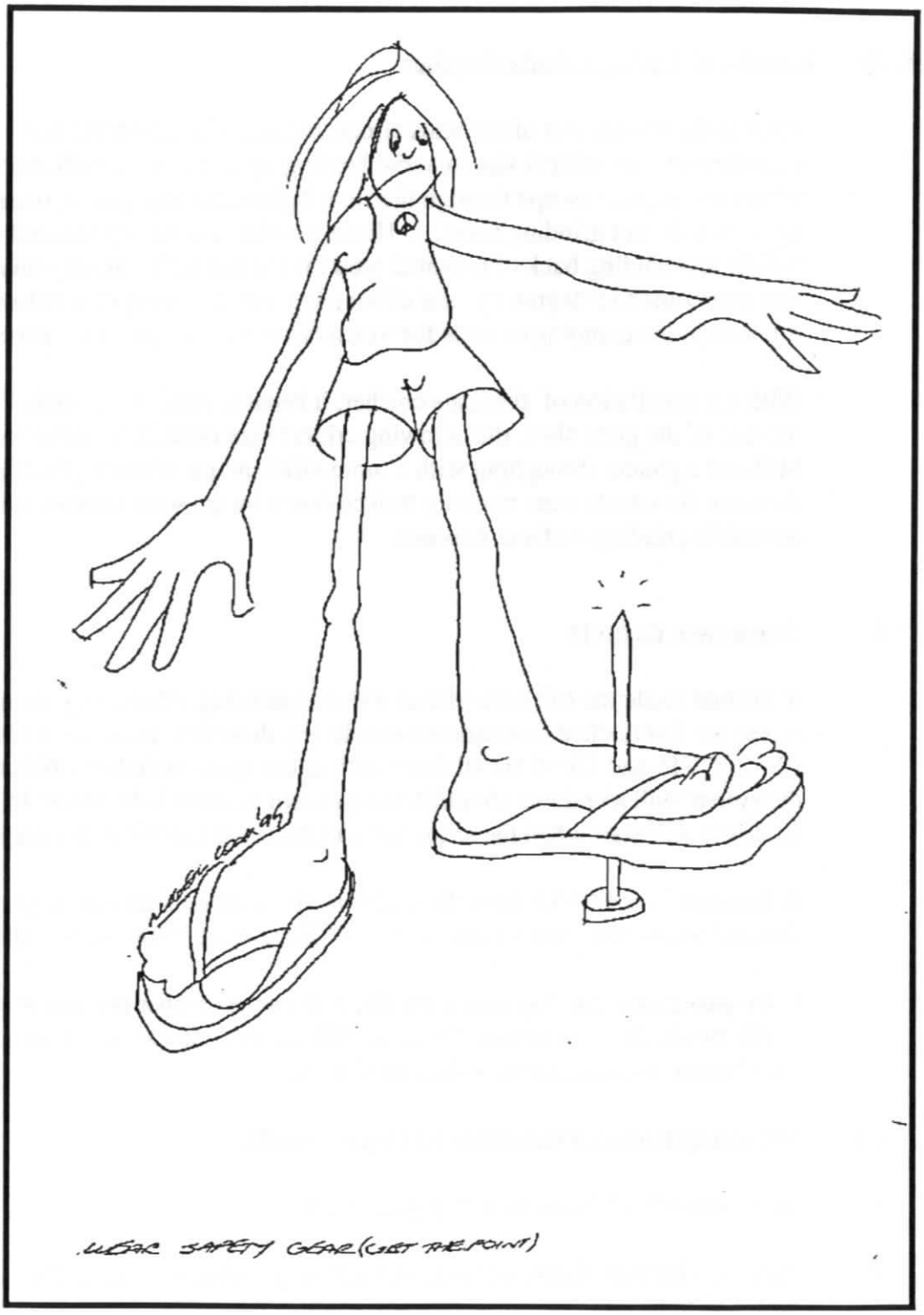
Weight of metre sample = (sample weight ÷ 1,000,000) tonnes
ie. In this instance 0.0343381 and 0.0344692 tonnes

Metres per second = 30 / 85.58 = 0.3505

0.3505 x 0.0343381 x 3600 (seconds in an hour) = 43.33 actual tph
For second sample 0.3505 x 0.0344692 x 3600 = 43.49 actual tph

Factors = $\frac{43.33 \text{ (actual tph)}}{40.90 \text{ (indicated tph)}} = 1.059$ & $\frac{43\text{-}49}{40.90} = 1.06340.9$

Average factor = 1.061 ie. CV5 read 61 tonnes short over 1000 tonnes.



Nailed for his sins! (and there are several)

CHAPTER 6 THE SCATS CIRCUIT OPERATIONS

A: Benefits of having a Scats Crusher

Prior to the installation of the scats circuit considerable problems were experienced with critical size material locking up in the A. G. Mill. Much material whilst too large to escape through the slots in the discharge grates, became too light for efficient grinding to occur. Hence problems were experienced with mill weight and holding back of potential feed for the ball mill. Initially this difficulty was overcome to a degree by careful blending, the enlarging of the slots and at times even the dumping of scats for treatment at a more opportune time.

With the installation of the scats crusher, it became possible to further increase the size of the grate slots, this allowing critical size material to leave the A. G. Mill and a greater throughput with a more efficient use of the regrinding mill. At the same time scats were not only broken down by the scats crusher, but had more amenable grinding surfaces exposed.

B: The scats circuits

In normal mode the full scats circuit will be operating. All conveyors and the screen are interlocked to shutdown should any drive fail. In addition CV11, CV12, CV15 and CV16 are all fitted with under speed switches which ensure that the system will shutdown should belt slip occur or drive belts break. In this mode all drives will start when the sequence start button is pushed in the control room.

A flop gate in the CV12 drop chute allows the scats crusher product to be directed across the scats screen or on to CV9 and back to the A. G. Mill.

In by-pass mode, the flop gate must direct the scats crusher product back to CV9. In this mode the scats screen, CV15 and CV16 will not start when the sequence start button is pushed in the mill control room.

C: Switching from normal mode to by-pass mode.

1 Switch the CV12 drop chute flop gate to CV9

2 Turn the vibrating feeder off as CV12 will stop and re-start when the circuit is switched to by-pass.

3 Select by-pass in the control room. The screen, CV15 and CV16 will continue to operate and should be shut down as soon as they are empty.

D: **Switching from by-pass mode to normal mode.**

1 Ensure that all of the drives have ready lights and are in auto.

2 Turn the vibrating feeder off as CV12 will stop and restart along with the rest of the circuit.

3 Direct the flop gate in the CV12 drop chute back to the screen when the full circuit is running.

E: **Factors influencing the operation of the scats crusher.**

Factor	Benefit
Feed must be evenly distributed around the crushing chamber.	*Allows even wear of manganese.*
Feed should be non-segregated, ie. a range of sizes from fines to coarse material	*Allows for more rock crushing rock action and reduces the overall wear of manganese.*
The crusher should be choke fed .	*Facilitates even distribution of feed and less manganese wear.*
Discharge from beneath the crusher should preferably be a straight drop and not hindered at all	*Prevents build up under the crusher and possible damage to components of the main shaft assembly.*
Metal objects should be removed from feed.	*Reduces damage to the manganese by large objects such as grinding balls*
There should be some form of de-watering facility prior to the crusher.	*Helps prevent build up of clay materials which could restrict discharge from beneath crusher.*
The vibrating feeder should be kept clean.	*Prevents restriction of feed flow into the crusher.*
Trash material, eg rubber, should be removed from the circuit.	*Helps prevent impedance of feed through the crusher and uneven wear.*
Largest sized material in feed should not exceed 80% of crusher feed opening.	*Prevents damage caused by oversized material and limits the amount of smaller material escaping crushing action.*

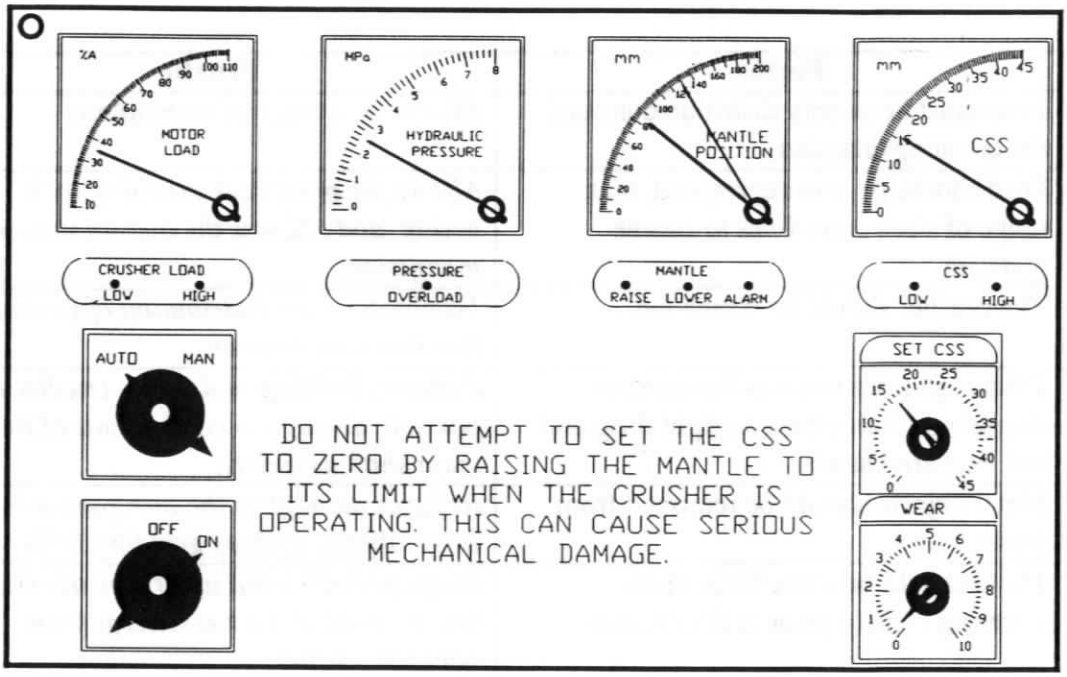
Table 6.1 - Factors influencing operation of scats crusher.

Any damage which may occur to the profile of either the inner or outer mantles of the crusher will inevitably reduce the efficiency of the crusher since uniform wear of both surfaces ensures better crushing. Similarly if the profiles become uneven, wear will be hastened and eventually some of the benefits of having the crusher in the circuit offset by increased costs.

F: **Adjusting the Wear Compensation and Gap when the Scats Crusher is stopped.**

This procedure may be carried out in its entirety from the control room but this is not desirable as one should ensure that the crusher is free of foreign material, rubber, etc before doing the following:

1 Ensure that the Auto/Manual switch on the control panel (see figure 6.1) in the mill control room is still in the auto position.



6.1 Scats crusher setting controls.

2 Depress the vibrating feeder local stop button and then wait for the crusher to run empty.

3 Depress the local stop button for the crusher. Check that there is no rubber or other material that could impede the movement of the inner mantle, inside the crusher. If need be use the local control to lower the mantle so as to enable removal of such material. Shine a torch down into the crusher to check for build up of clay materials. Observe the procedures and precautions set out in the accompanying table when cleaning out the crusher.

4 On the control panel in the mill control room, turn the CSS control knob to zero and then wait for the CSS gauge to move to zero. Make sure that the gauge does go right back to zero.

F: **Adjusting the Wear Compensation and Gap when the Scats Crusher is stopped (continued)**

5 Turn the wear compensation knob slowly clockwise until the hydraulic pressure gauge moves above 1 MPa. The CSS gauge will now be above zero. This indicates that the mantles are now touching.

6 Slowly turn the wear compensation knob anti-clockwise until the CSS gauge again indicates zero gap.

7 Turn the CSS control knob to the desired setting.

8 Pull out the local stop button for the crusher.

9 When the crusher is operating pull out the feeder stop button.

G: **Adjusting the Wear Compensation and Gap when the Scats Crusher is Operating.**

1. Stop the vibrating feeder at the local station and wait for the crusher to empty out.

2. Note the CSS setting on the gauge and then lower the mantle right away by turning the CSS control knob clockwise.

3. Physically check that there is nothing impeding the lowering of the mantle.

4. Turn the CSS control knob anti-clockwise so that the CSS gauge returns to the original setting.

5. Lead the gap in four positions around the crusher chamber and then measure the lead size. The smallest side should be the actual closed side setting.

6. If the actual gap found by leading is different to the CSS gauge, use the wear compensator to adjust the gauge to the actual gap. Record the difference on the crusher log sheet.

7. Adjust the crusher gap to the desired setting by using the CSS control knob.

8 Pull out the feeder local stop button.

H: Cleaning out the Scats Crusher from the outside.

SAFETY PRECAUTIONS

- **Apart from the normal safety boots and helmet wear goggles and gloves when chipping clay build up away from inside the crusher.**
- **Do not put either legs or arms between the mantles.**
- **Do not stand on material above the gap.**
- **Always tag out CV12 in the local control centre when barring out the crusher drop chute through the inspection hatches.**
- **Always isolate and tag out CV11, the vibrating feeder, the crusher and CV12 when it is necessary to enter the crusher drop chute.**
- **Always complete a Mechanical Access Permit before entering the crusher drop chute.**
- **Always have another worker standing guard when you enter the drop chute.**

1 Tag out CV12 in the local control centre.

2 Remove the inspection covers on both sides of the drop chute.

3 Using a crow bar chip away the build up. This is not an easy task and the temptation is always to use an air spear, but this should only be used as a last resort since compressed air can force grit, etc back through the seals under the inner mantle and contaminate the lubrication system.

I: Cleaning out the Scats Crusher Drop Chute from the Inside

1 In the local control centre isolate and tag out CV11 (only necessary if the vibrating feeder is empty)the vibrating feeder, the crusher and CV12.

2 Fill out a Mechanical Access Permit.

3 Ensure that there is another person on call outside the drop box.

I: **Cleaning out the Scats Crusher Drop Chute from the Inside (continued)**

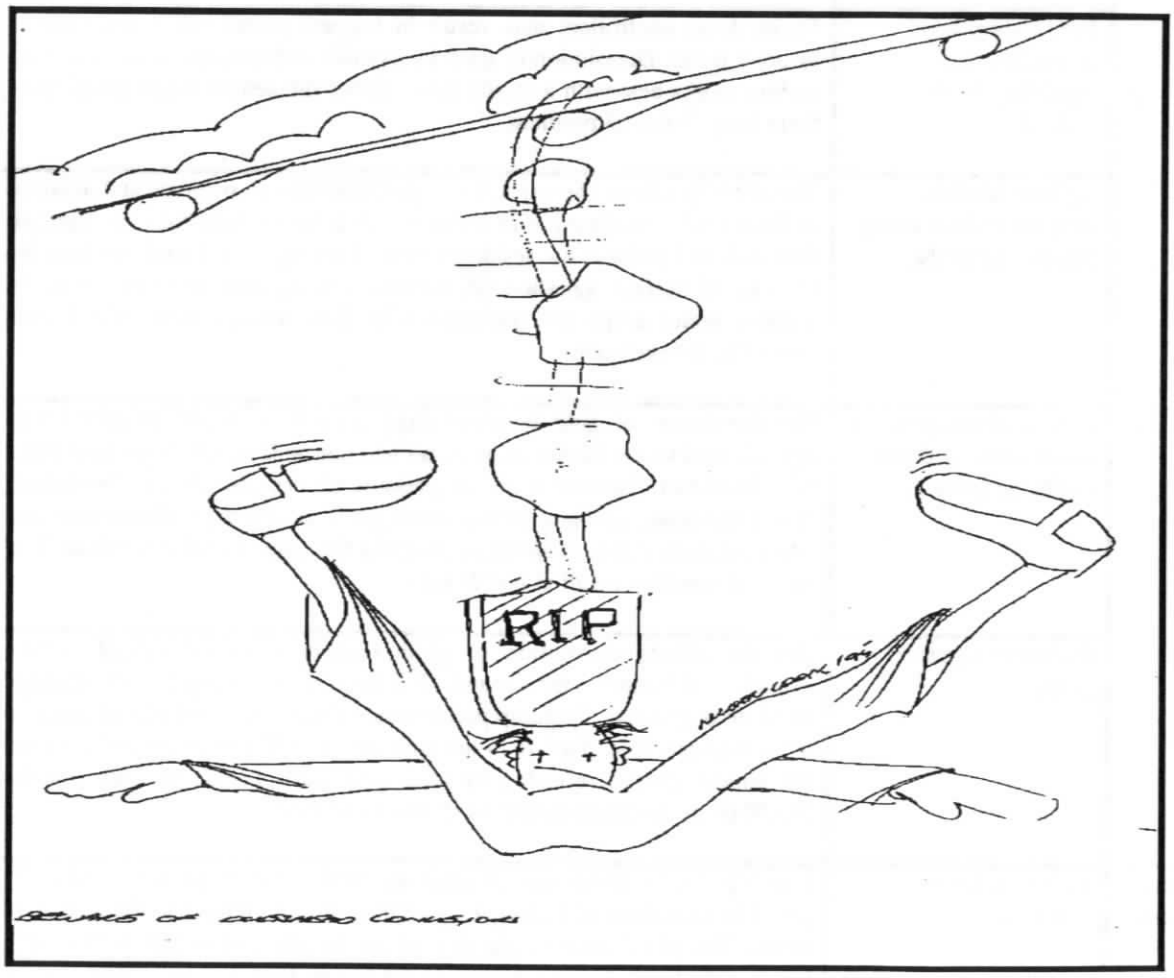
4 Place a piece of chipboard on CV12 to enable sliding along the conveyor so as to enter the drop chute.

5 Put on helmet, gloves, mask and goggles before entering the drop chute.

6 Avoid blocking off your exit when chipping down material. Pass it out to your offsider through the inspection hatch.

7 Take frequent breaks and drink plenty of water when doing this task during hot weather.

8 Remove tags and sign off the Mechanical Access permit. Then complete the Mechanical Access permit cancellation docket.



A FLATTENING EXPERIENCE

CHAPTER 7 TANK CIRCUIT OPERATIONS.

Factors influencing the efficiency of the Tank Circuit

These factors relate broadly to mechanical factors, the nature of the feed pulp and lastly the control of reagents and carbon. All of these classifications may relate to any factor which may impede the flow of pulp through the leach and adsorption tanks, i.e. effect residence time, and/or effect the exposure of that pulp to reagents.

A: Mechanical Factors.

The most common mechanical problems are detailed in the table below.

Problem	Effect and Action required.
Feed pumps not operating to maximum efficiency	Effect plant capacity, especially when feed hoppers overflow resulting in the need to double handle pulp. Maintenance is required if the pump cannot handle normal feed and is drawing maximum amps.
Feed hopper level controllers not regulating level properly.	Faulty level controllers may result in hoppers overflowing and surging through tanks. Dissolution of gold by cyanide and adsorption of gold onto carbon works best with a steady flow. Either the sensor needs cleaning or there is an electrical problem.
Agitator blade/s missing and not being agitated properly.	This directly effects the exposure of gold particles to reagents and aeration and can lead to settling out in a tank which in turn effects the flow through that tank and reduces the residence time. First signs of a problem may be (I) lack of surface agitation (ii) wobbling of agitator shaft (iii) drop in agitator motor amps (iv) problems with flow through tank. The blades should be checked out.
Failure of low pressure compressor and pulp not being aerated	For dissolution of gold to occur oxygen must be added in addition to cyanide and water. Hence poor or no aeration will lead to high gold solid tails. Incorrect distribution of low pressure air can also effect dissolution. If a compressor problem is suspected get it attended to. Remember that when the compressor is operating properly the output should oscillate. Too much air can also result in NaCN loss.
Failure of Cyanide pump.	Directly affects dissolution of gold. Operators should visually check cyanide outlets during their rounds. It is important that any fall off, whether absolute or gradual , in pump performance should be noted and acted upon as soon as possible. Failure to maintain constant NaCN levels in the circuit, are almost always reflected by high final tails. In-line strainers on the NaCN pump feed line should be checked regularly.
Failure of Lime regulator.	Directly effects dissolution of gold and will result in formation of HCN gas. The formation of hydrogen cyanide is directly related to the acidity of water. The pH Granites pulp should not be allowed to fall below 9.2, below which the loss of NaCN to HCN gas becomes excessive and a possible hazard to operators under some environmental conditions, eg. on hot still nights. Operators should check the lime discharge on to CV9 when doing their rounds. If for some reason the lime will not discharge, they should switch over to caustic input.

Table 7.1 Mechanical type problems and their affect on the tank circuit.

Table 7.1 Mechanical type problems and their affect on the tank circuit (Cont.)

Problem	Effect and Action required.
Drop in performance of process water pumps.	Causes fluctuation of pulp density which may affect everything from the mills to the tailings pumps. Tanks are particularly susceptible to sudden changes in density. Mill operators should advise the reagents operator if they suspect a problem.
Failure of raw water pump.	Tailing gland pumps will shut down and the gravity circuit may bog up. Problems may occur also when the pumps are ok but there is indiscriminate use of hoses on the mill and tank floors since this affects mill and tank densities. Operators cleaning up should not leave hoses running unattended. They should also make sure that their fellow operators know that they will be hosing up.
Blocking Kambalda screens in adsorption tanks.	This may be caused by gradual 'pegging up' of the wedge wire screens or by a sudden change of pulp characteristics. Apart from a changing level of the pulp in the tanks, possible problems may be indicated earlier on by settling inside the Kambalda screen. The surface of the pulp becomes almost clear water. If blocking of screen cannot be overcome by cleaning it may be necessary for the shift foreman to cut back on the mill feed.
Poor performance and/or control of carbon transfer pumps.	Carbon density levels must be regularly checked by the reagent operator. Excessive carbon densities can cause Kambalda screen blockages and likewise very low densities in a tank my cause loss of balance in the flow relationship between tanks. See the diagram below.

Figure 7.1 below illustrates a common problem that occurs in adsorption tanks when operators fail to keep the screens clean.

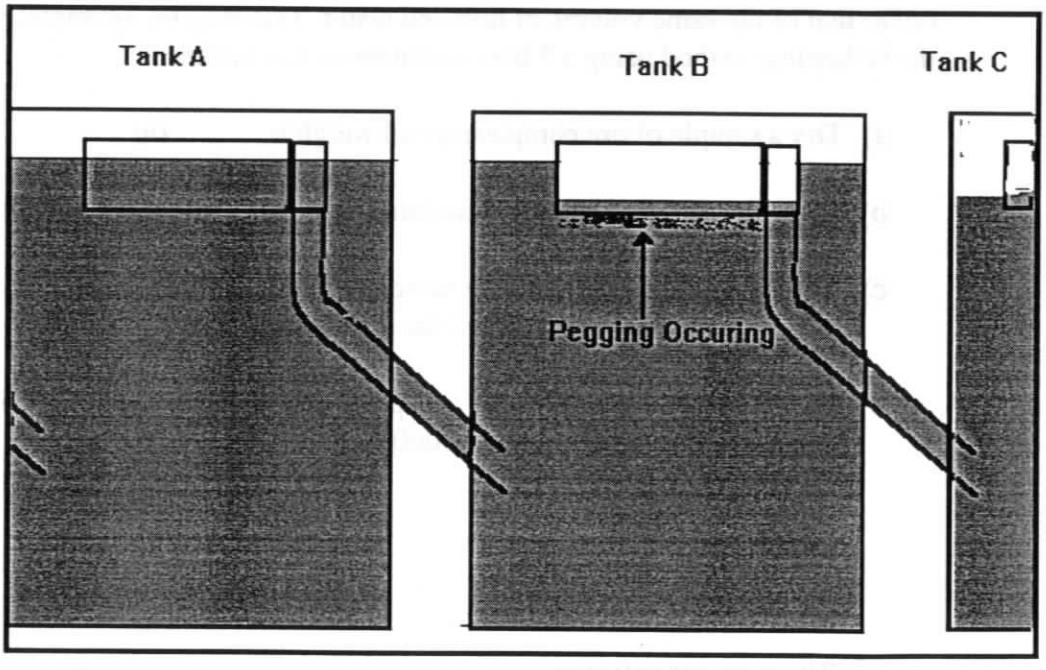


Figure 7.1 The effect of pegging on tank flow.
This if not corrected quickly will lead to overflowing of the launders in both tanks A and B and carbon will escape into tank C possibly causing the screens in that tank to block and the eventual overflow of all of the tanks.

B: Factors relating to the Characteristics of the Feed.

Most commonly used terms when describing the nature of pulp are:

- Density
- Specific Gravity (SG)
- Viscosity.
- Residence Time

1 Density

refers to the percentage solids by weight which is most accurately obtained by comparing the dry weight of a given sample with its wet weight as sampled from the pulp stream. In sample preparation this is done by determining the net wet weight of the sample, then filtering off the solutions and drying the solids thoroughly. The net weight of the dry solids is then recorded and the percentage solids calculated by the formula

$$\frac{\text{Net Weight of Dry Sample}}{\text{Net Weight of Wet Sample}} \times 100$$

This procedure is of course too time consuming for mill operations personnel, but they are fortunate in that given the specific gravity of an ore, they can use the Marcy Scales to determine a reasonably accurate percentage solids.

2. Specific gravity (SG)

is in this instance is the mass by weight of a given volume of absolutely dry ore to that of the same volume of distilled water. This may be estimated by the following method using a 1 litre container in this instance:

a) Dry a sample of ore completely and weigh it. *(a)*

b) Place the sample in a 1 litre container and record the gross weight. *(b)*

c) Top the container with above sample up with distilled water so that it is completely full. Record the gross weight. *(c)*

d) Apply the following formula accepting that the net weight of a 1 litre container of distilled water is 1000 g.

$$SG = \frac{(a)}{1000 - [(c) - (b)]}$$

There are other factors to be taken into account when determining an SG, these being:

- The size of the sample - is it truly representative of an ore body?

B: Factors relating to the Characteristics of the Feed (continued)

- Resistance of some ores to wetting. A wetting agent may be required.
- The need to remove all entrapped air from the sample when obtaining the gross weight of the container plus sample topped up with water (c)
- The temperature of the water

3 Viscosity

This is a term use to express the readiness with which a fluid flows when it is acted upon by an external force. The absolute viscosity of a fluid is a measure of its resistance to internal deformation or sheer. Molasses is a highly viscous fluid whilst water is comparatively much less viscous; it being only what is added to water that causes problems sometimes. When this problem persists it is usually necessary to drop the feed rate or to use a viscosity modifier. Dropping the density sometimes helps but it is wise to remember that this action may lead to undesirable settling of solids in the tanks.

4 Residence Time

This term refers to the actual time taken by solids to pass from the leach feed to tails. Density has considerable bearing on this factor. Table 7.2 on the next page clearly demonstrates the effect of a change in % solids upon flow through tanks. On an average a one per cent change in % solids at 200tph produces around a three per cent change in flow through the tanks. If the tanks are already operating at close to maximum capacity, the effect of a sudden drop in density can be dramatic. Increasing % solids at constant feed rate increases tank retention time but may not be beneficial to either flow through the tanks or recovery.

Changes in volume are not the only factor to consider, when changing density. Often a lighter density pulp simply cannot force a preceding high density pulp through the circuit and this can lead to overflowing of both leach and adsorption tanks. Alternatively an increase in % solids could be most undesirable should the pulp be of a highly viscous nature since this would make it even more difficult for the pulp to pass through the tanks. Generally when there are viscosity problems it is best to keep the densities relatively low. (present experiences indicate 44 to 45%)

B: Factors relating to the Characteristics of the Feed (continued)

Tph	C.O.F %solids	Tph of pulp	Total volume of pulp litres/hour	Percentage reduction in pulp volume	Retention Time hrs
200	40	500	376923	0.0	17.0
200	41	488	364728	3.2	17.6
200	42	476	353114	6.4	18.1
200	43	465	342039	9.5	18.7
200	44	455	331469	12.6	19.3
200	45	444	321368	15.6	19.9
200	46	435	311706	18.6	20.6
200	47	426	302455	21.6	21.2
200	48	417	293590	24.5	21.8
200	49	408	285086	27.4	22.5
200	50	400	276923	30.3	23.1

Table 7.2 The effect of a change in density upon volume in litres per hour and retention time

Should the percentage solids become too low in a tanks circuit there may also be a problem of settling of the relatively coarse particles. Likewise marked changes in either % solids or viscosity can affect the distribution of carbon concentrations in the tanks.

It could be that under some circumstance, when a change in density is absolutely necessary, that the feed rate too must be adjusted. For example if the density is to be dropped two per cent it may just be advisable to reduce feed rate while maintaining water addition constant.

5. General rules for maintaining operational efficiency of the tanks circuits:

- Regularly monitor the equipment detailed in Table 7.1.
- Avoid fluctuations in % solids.
- Avoid sudden changes in % solids.
- As a general rule use Freevis while maintaining % solids if there are high viscosity problems.
- Maintain the correct carbon level distribution in the adsorption tanks.

- Encourage all workers engaged on cleaning, etc. to advise the mill operators when they are going to use additional water for hosing up.

- Regular checking of Kambalda Screens is a must. Don't wait for trouble to arise.

- All operators should monitor the actual levels of tanks (including all plant water supplies) and pump feed hoppers as they do their rounds. Major spills inconvenience everyone and affect gold recovery.

C: The Control of Reagents and Carbon

No matter how efficiently the leach and adsorption tanks are operating, maximum recovery of gold cannot occur without continual regulation of Cyanide input and the maintenance of carbon levels.

The CIP process relating to the tanks involves two main reactions, the dissolution of gold by cyanide and the adsorption of gold onto carbon.

1 The dissolution of gold by cyanide

The chemical reaction taking place during the dissolution of gold is shown below:

$4\ Au + 8\ NaCN + O_2 + 2\ H_2O \rightarrow 4\ NaAu(CN)_2 + 4\ NaOH$, or in long hand

GOLD + SODIUM CYANIDE + OXYGEN +WATER → GOLD CYANIDE + CAUSTIC SODA.

Dissolution may be hindered at the Granites by the gold being associated with arsenopyrite, causing excessive consumption of cyanide. Other associated minerals, such as copper and some sulphide minerals are dissolved by cyanide and this too causes excessive consumption of cyanide. Other minerals react with oxygen, hence restricting the oxygen for the above reaction.

It is essential that the pH of the pulp be maintained at 9.3 and above since cyanide when dissolving in water forms hydrogen cyanide gas.

SODIUM CYANIDE + WATER → HYDROGEN CYANIDE + CAUSTIC SODA.

As the acidity of the water increases the amount of hydrogen cyanide produced will increase. If the free alkali of the cyanide solution is maintained, the decomposition of cyanide is negligible. **Hence by maintaining the pH level in the tanks operators will prevent excessive waste of cyanide and of utmost importance, maintain safe operating conditions.**

Operators can also help ensure the efficiency of dissolution process by maintaining adequate aeration in the leach tanks. The amount of oxygen dissolved in water affects the rate of gold dissolution.

1 **The dissolution of gold by cyanide (continued)**

The benefits of maintaining an adequate pH by adding lime or caustic soda are summarised below.

- Prevents loss of cyanide by hydrolysis. (The above reaction)
- Decomposes bicarbonates in the mill water before using it in cyanidation.
- Neutralises acidic compounds such as ferric salts and magnesium sulphate in mill water before using it in cyanidation.
- Neutralises acidic constituents in the ore.

2: The adsorption of gold on to carbon.

The adsorption of gold by carbon is influenced by:

- Time: The longer the carbon is in contact with gold solution, the more gold it will adsorb. The rate of adsorption decreases as the loading increases.
- Gold concentration: The more gold in solution, the more carbon will adsorb. The lower gold concentrations require the fresher regenerated carbon, this being the reason why our regenerated carbon is always added to tank A7.
- Carbon activity: The higher the activity the better the carbon will adsorb gold.
- Temperature: Gold adsorption occurs at a faster rate at higher temperatures.

FOULANT	SOURCES	REACTIVATION
Calcium Carbonate	Lime, ore, water supply.	Acid wash
Magnesium Hydroxide	Water	Acid wash
Silica	Lime, ore.	Regeneration Kiln
Iron oxides, cyanides	Ore Calcine	Acid wash
Copper compounds	Ore	Acid wash
Organics	Wood, oil, etc.	Regeneration Kiln.

Table 7.3 Types of fouling that can effect carbon activity

3: Procedure for doing NaCN titrations.

a) Take 250 ml sample of pulp from tank.

b) Filter off 25 ml.

c) Rinse 10 ml measuring cylinder with some of above filtrate and then empty it.

d) Fill the measuring cylinder to 10 ml.

e) Add 7 drops of rhodanine indicator to measuring cylinder and swirl it to ensure mixing.

f) Fill the burette with silver nitrate ($AgNO_3$ 0.01 M (molar) strength) until it reaches the `0´ mark.

g) Allow the silver nitrate to drip into the filtrate/rhodanine mixture, swirling the measuring cylinder all of the time.

h) When all of the solution in the measuring cylinder first changes colour (for most it would change to salmon pink) read the silver nitrate usage off the burette..

i) Insert a `0.0´ in front of whatever the usage was and record on log sheet.

4: Procedure for taking titration of NaCN mix.

(Must use the separate equipment that is stored under the bench)

a) Take a 30 ml sample of NaCN solution from the outlet at tank L1.

b) Half fill the 100 ml measuring cylinder with potable water.

c) Pour 10 ml of the NaCN sample into the 10 ml measuring cylinder and then pour this into the 100 ml measuring cylinder.

d) Rinse out the 10 ml measuring cylinder with potable water, pouring all of the rinse water into the 100 ml measuring cylinder.

e) Top up the 100 ml measuring cylinder to the 100 ml mark with potable water and swirl cylinder to mix well.

f) Take a 10 ml sample from the 100 ml measuring cylinder.

g) Wash out the 100 ml measuring cylinder with potable water and shake all excess water from it.

4: Procedure for taking titration of NaCN mix. (Continued)

h) Half fill the 100 ml measuring cylinder with potable water again.

i) Pour the 10 ml sample from step `f.´ into the 100 ml measuring cylinder.

j) Rinse out the 10 ml measuring cylinder with potable water, pouring all of the rinse water into the 100 ml measuring cylinder.

k) Top up the 100 ml measuring cylinder to the 100 ml mark with potable water and swirl cylinder to mix well.

l) Take a 10 ml sample from the 100 ml measuring cylinder. (This will now be a 1% solution)

m) Add seven drops of rhodanine indicator solution to the 10 ml sample and swirl to mix in well.

n) Make sure that the burette is filled to the `0´ mark with silver nitrate.

o) Allow the silver nitrate to drip into the NaCN/potable water/rhodanine mixture, swirling the measuring cylinder all of the time.

p) When all of the solution in the measuring cylinder first changes colour (for most it would change to blood red) read the silver nitrate usage off the burette. The reading is direct, ie. 24.2 ml indicates a NaCN strength of 24.2%

q) Record the result on the bottom of the log sheet.

r) Rinse out all of the equipment well and when dry store it underneath the bench again.

High Tails - Cost of and Possible Causes

Attitude towards loss of gold to tails varies according to circumstances at particular plants. In some instances the cost of avoiding it is prohibitive and in others a tail of say 0.55 grams per tonne might seem perfectly reasonable if the overall recovery was above say 96%.

The important thing to remember about gold going to tails is that it is a loss and no avoidable loss is acceptable.

Tph	C.O.F % Solids	Tph Solids	Tail ppm Au	Cost @ $17/gram	Loss in 24hrs	loss in a Year
200	45	200	0.1	$340	$8,160	$2,978,400
200	45	200	0.2	$680	$16,320	$5,956,800
200	45	200	0.3	$1,020	$24,480	$8,935,200
200	45	200	0.4	$1,360	$32,640	$11,913,600
200	45	200	0.4	$1,700	$40,800	$14,892,000

Table 7.4 Solids gold loss to tails

Tph	C.O.F % Solids	Tph Solutions	Tail ppm Au	Cost @ $17/gram	Loss in 24hrs	loss in a Year
200	45	244	0.01	$41	$996	$363,365
200	45	244	0.02	$83	$1,991	$726,730
200	45	244	0.03	$124	$2,987	$1,090,094
200	45	244	0.04	$166	$3,982	$1,453,459
200	45	244	0.04	$207	$4,978	$1,816,824

Table 7.5 Solution gold loss to tails

All too often the immediate response to high tail losses is to drop tonnage. This however should be the last action to consider. Why drop tonnage, ie lose production, if the problem can be overcome by more acceptable action. The golden rule is

Look for the cause.

Possible Causes

Poor grind

- Check cyclones - worn spigots, etc
- Mill densities too low - not grinding properly
- Cyclone overflow density too high - results in coarse grind with possibly high tails.
- Ball charge low as indicated by power draft.
- Mill overloaded. Power draft will start to fall and grinding becomes less efficient.

Reagent levels wrong

- Cyanide levels too low - check constantly.
- Low pH - free cyanide concentration drops because most of the cyanide is present as HCN which can escape as a gas.

High Tails (continued)

Air addition to tanks not adjusted properly.

- Not enough air - will retard dissolution of gold
- Too much - can lead to wastage of cyanide due to oxidation. Remember compressed air is expensive too.

Bad ore blend.

- A particular ore may need a longer residence time, eg in the past Shoe High Grade has caused problems if blended with Callie at a total tonnage throughput of 200 tph.
- Sulphides in the ore may be using up cyanide or slowing down the dissolution process.

Settling occurring in the tanks causing reduced leaching time and high tails.

- Density too low

.

Carbon problems

- Levels too low - constant addition of carbon is better than allowing the levels to fall and then adding a tonne or more at a time.
- Tank A7 carbon content too low - keep this tank around 20 grams per litre.
- Carbon activity poor - regeneration kiln not working properly or carbon being fouled by poor water or oil. Acid wash may not be good enough this allowing inorganics to foul the carbon.
- Carbon too fine - keep the regenerated carbon screen clean so that fine carbon may go to tails before it adsorbs gold.

High viscosity

- This can lead to poor solid/solution contact resulting in high tails.

Don't just wait for high tails to occur as by then it might be anything up to 20 hours too late (Retention time plus the time that it takes the laboratory to process the samples). If you suspect that something is wrong advise your supervisor immediately.

CHAPTER 8 OPERATOR DUTIES

The following rosters are merely a guidance for programmed monitoring of the plant. The operators must also be prepared to monitor the plant between rounds.

A: Duty roster of the mill operator. ***(night shift is identical apart from having to press and dry the mill sample at 23:30)***

Time	Task
0630	Mill round Verbal handover with outgoing mill operator. Check and record gauges and readouts in mill control room. Density reading on COF, CUF, SMD and BMD; record and sample. Temperature reading on A.G. Mill and record. Check Ball Mill gauges. While doing above - generally check mills, trommels, feed chutes, spillage's, temperature of pump barrels etc. Make adjustments as necessary to water, feed etc. Check and record cyclone pressure. Adjust as necessary.
0730	Circuit Round Mill round. Check and record scats crusher readings. Visually check scats crusher, scats hopper, chutes, screen and check on reasons if excess spillage anywhere. Walk along CV9, check rollers. Clean off weightometer. Check CV7 & 8 drop chutes, belts, AF1 & 2. Check hydraulics of AF1 & 2 and report verbally leakages etc to maintenance. Check lime silo and feed. Check flow meters at tank farm, overflows, tank levels, return valve, leakage at pumps etc. Check CV5 if in use. Check trash screen, leach pumps and for spillage's or leakages.
0830	Mill round as per 0630.
0930	Circuit round as per 0730.
1030	Mill round as per 0630.
1130	Circuit round. In addition take sample bucket to sample preparation. Weightometer readings recorded and other requested data.
1230	Mill round as per 0630.
1330	Circuit round as per 0730.
1430	Mill round as per 0630.
1530	Circuit round as per 0730
1630	Mill round as per 0630.
1730	Circuit round as per 0730
1830	Mill round as per 0630. Before handing over to incoming operator note any ongoing instructions on notice board. Verbal handover.

B: Other duties of the Mill Operator

- keeping process tanks at acceptable levels and cleaning screens.
- keeping trommels and drop chutes at mill clean and open.
- keeping feeder and crusher clean and build up free and keep CV12-9 drop chute clear.
- adjusting scats circuit as mill weight indicates.
- in cooperation with the shift boss, clear scats crusher, lower it away, check for build-up and clear as needed, lead crusher gap and record.(day shift)
- add balls to the regrind mill as required or advised.(day shift)
- keeping an eye on gravity circuit and report any anomalies to the gold room.
- keeping trash, scats and wash out (scats crusher) bins empty and the passive feeder pad clean.
- feeding scats to regrind so that build-up is minimised.
- answering alarms and rectifying faults or advise departments of the alarms affect ie power house, R.O. plant, goldroom etc.
- keeping trash screen working effectively, acid washing as needed.
- mixing NaCN as needed.(normally night shift)
- the recovery of loaded carbon for strips (normally night shift)
- keeping clean the A.G. Mill area (including feed chute area), the ball mill area, under CV10, 11 and 12, CV9 and 5 counter weights and removing other build-up of spillage etc.
- cleaning cyclones.

The mill operator should also assist with:

- maintenance upkeep of circuit
- writing of works orders.
- answering telephones when practical and take messages or transfer calls as needed.
- cleaning the mill control room.
- relieving on the crusher when required.(day shift)
- rubbish disposal; degreasing of the mills and auxiliary equipment. (degreasing done Tuesday day shift)
- Draeger testing on a weekly basis and when else required.

SAFETY PROCEDURES

The Handling of Cyanide.

Cyanide poisoning can occur by three ways.

Inhalation of hydrogen cyanide gas
Ingestion via body orifices
Adsorption through skin

Never eat or smoke in an area where cyanide is used. Both acts risk the ingestion of cyanide should hands contact the mouth.

Always wash your hands prior to doing either of the above and then only eat or smoke in an approved area.

Always wear rubber gloves in addition to the normal helmet, glasses and safety boots when handling pulp from the tanks.

When performing duties that may expose oneself to concentrated Cyanide, eg. mixing new batches of cyanide, cleaning in-line strainers or cleaning either the carbon backup screen or the final tailings screen the following must be worn.

Helmet
The approved mask
Glasses
Long Gloves
Rain coat and plastic trousers.
Rubber safety boots.

If any breathing discomfort at all is felt when working in an area where cyanide is used always put on your mask. The safe limit is 10 parts per million but in some areas, eg. near the tailings screen this is often exceeded. Before work commences in any problem area, eg. maintenance work on the tailings screen or the cleaning out of or maintenance to tanks a Draeger test should be done.

CYANIDE IF HANDLED CARELESSLY KILLS

QUICKLY

C: Monitoring of tanks by reagent operator.

The reagent operator must continually monitor the Cyanide, pH and carbon levels in the tank circuit to ensure that they stay within the parameters set for a particular ore blend. In general these levels are set at the minimum required to achieve maximum recovery whilst maintaining safe operation conditions and are normally around:-

- Cyanide 0.030- 0.035% at Tank L2 and 0.018 - 0.020% at Tank A7
- pH 9.40 - 9.50 at Tank L2 and 9.20 at Tank A7

- Carbon levels for all of the absorption tanks have currently been set at 15 grams per litre (minimum A1 to A6) and 20 grams per litre (A7).

In order to maintain the desired levels the reagents operator follows a regular schedule of checks on the tanks circuit as set out in the table below.

D: Duty roster of the reagent operator.

Time	Task
00:30	Full Round Sample tanks L1, L2, L4, L6, L8, L9 and tails - do NaCN titration and pH on each sample and record these on log sheet. Put one dipper of pulp from leach feed and tails into the relevant buckets. Put 80 ml of tails filtrate in marked bottle for lab. Adjust NaCN and Lime (or NaOH if being used) as required.
01:30	Sample tank L2 - do NaCN titration and pH and record these on log sheet. Adjust input as required. Put one dipper of pulp from leach feed and tails into the relevant buckets. Take carbon count on all absorption tanks. Record on log sheet and adjust levels as required.
02:30	Sample tanks L2 and tails - do NaCN titration and pH and record these on log sheet. Adjust input as required. Put 80 ml of tails filtrate in marked bottle for lab. Put one dipper of pulp from leach feed and tails into the relevant buckets.
03:30	As for 01:30
04:30	Full Round as for 00:30
05:30	As for 01:30
06:30	As for 02:30 - Day shift to check compressors and do a NaCN titration of sample taken from the hose outlet above tank L1 inlet launder.
07:30	As for 01:30. Take the 12 filtrate sample bottles to laboratory.
08:30	Full Round as for 00:30
09:30	As for 01:30
10:30	As for 02:30
11:30	Full Round as for 00:30 Sample buckets to sample preparation. 20 ml of nickel disulphate to new tails sample bucket.

Duty roster of the reagent operator (continued)

Time	Task
12:30	Full Round Sample tanks L1, L2, L4, L6, L8, L9 and tails - do NaCN titration and pH on each sample and record these on log sheet. Put one dipper of pulp from leach feed and tails into the relevant buckets. Put 80 ml of tails filtrate in marked bottle for lab. Adjust NaCN and Lime (or NaOH if being used) as required.
13:30	Sample tank L2 - do NaCN titration and pH and record these on log sheet. Adjust input as required. Put one dipper of pulp from leach feed and tails into the relevant buckets. Take carbon count on all absorption tanks. Record on log sheet and adjust levels as required.
14:30	Sample tanks L2 and tails - do NaCN titration and pH and record these on log sheet. Adjust input as required. Put 80 ml of tails filtrate in marked bottle for lab. Put one dipper of pulp from leach feed and tails into the relevant buckets.
15:30	As for 13:30
16:30	Full Round as for 12:30
17:30	As for 13:30
18:30	As for 14:30
19:30	As for 13:30.
20:30	Full Round as for 12:30
21:30	As for 13:30
22:30	As for 14:30
23:30	Full Round as for 12:30 Sample buckets to sample preparation where the samples must be pressed - filtrate solutions to marked bottles and the solids broken up and placed under the quick dryer. 20 ml of nickel disulphate to new tails sample bucket.

E: Other duties carried out by the reagent operator

- keeping the tails and fine carbon screen clean.
- emptying the tails carbon basket as required.
- assisting with cleaning of Kambalda screens
- keeping the adsorption floor clean.

He is also responsible when on day shift to ensure that:

- the lunches are picked up each day
- the fuel, oil and water of the mill utility, fork lift and bobcat are checked each day.
- basic stores are kept up to date, eg. gloves, masks, paper towelling, etc.
- the mill rubbish bins are emptied on Tuesday for the incoming shift.
- the mill utility is cleaned on Tuesday for the incoming shift

REFERENCES

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Wills, B.A. Mineral Processing Technology - an introduction to the practical aspects of mineral recovery. Pergamon Press 1988

Western Australian School of Mines Gold Plant Operators Course Western Australian School of Mines 1988

Product Name **SODIUM CYANIDE**

Ingredients with Concentration and CAS No.	HYDROGEN CYANIDE	NOT PROVIDED	74-90-8
	SODIUM CYANIDE	VERY HIGH(>60%)	143-33-9

Synonyms CYANIDE OF SODIUM; HYDROCYANIC ACID, SODIUM SALT; NACN;
Appearance CRYSTALS, PILLOWS OR BRIQUETTES
Odour FAINT ALMOND ODOUR
Uses GOLD PROCESSING REAGENT; LABORATORY REAGENT; NOTE: RESTRICTED SUPPLY AND USE;
Supplier I.C.I. 089 470965
Poison Sched: 7 **Haz Chem:** 4X **U.N. #:** 1689 **Class:** 6.1(a) **Pkg Grp:** I

HEALTH HAZARD INFORMATION

Eye Corrosive-irritant. Contact may result in pain, redness, corneal burns and ulceration with possible permanent damage.

Inhalation Highly toxic-potentially fatal in low concentrations. Exposure may result in weakness, headache, nausea, vomiting, confusion, nervousness, breathing difficulties, convulsions, and death from respiratory arrest.

Skin Highly toxic-potentially fatal. Direct contact may result in irritation, skin rash and possible burns. Absorbed through the skin with toxic systemic effects.

Ingestion Highly toxic - potentially fatal. Ingestion may result in burns to the mouth and throat, nausea, vomiting, breathing difficulties, convulsions and death.

Hazard Summary Highly toxic. Use safe work practices to avoid any contact. Individuals with pre-existing kidney, respiratory, skin or thyroid diseases are at a greater risk of developing toxic cyanide effects. Cyanide is reported to cause damage to the central nervous system. Death usually occurs due to respiratory arrest.

PRECAUTIONS FOR SAFE USE

Flammability Non flammable. May evolve highly flammable and toxic gases of hydrogen cyanide when added to water or upon contact with moist air, acids, acid salts, or carbon dioxide.

Reactivity Contact with oxidizing agents (eg. nitrates, chlorates) may cause fires-explosions. Contact with acids, carbon dioxide or moisture releases flammable and highly toxic hydrogen cyanide gas.

Ventilation Do not inhale vapours (solutions) or dusts. Use in well ventilated areas. In poorly ventilated areas, mechanical extraction ventilation is recommended.

Personal Protective Equipment Butyl or neoprene elbow length gloves, coveralls, PVC or rubber boots and an approved full face Type B2 (hydrogen cyanide-HCN) respirator are recommended when handling. If handling large quantities or with prolonged exposure an approved full face air supplied respirator and full impervious coveralls are recommended.

PERSONAL PROTECTIVE EQUIPMENT

CVH

Colour Rating RED

Printed by: NORMANDY MINING LIMITED

Product Name *SODIUM CYANIDE*

FIRST AID PROCEDURES

Eye Flush gently with running water, holding eyelids open for 15 minute period. Seek immediate medical attention.

Inhalation If assisting a victim avoid becoming a casualty, wear a full face Type B2 (HCN) or air supplied respirator. Give oxygen and if necessary, artificial respiration. If giving mouth to mouth wash out patients mouth & lips-do not inhale patients expired air. Remove contaminated clothing & wash skin thoroughly. Transport to hospital immediately.

Skin Remove contaminated clothing and gently flush affected areas with soap and water. Product may penetrate skin and cause toxic systemic effects. Seek immediate medical attention. Launder clothing before reuse.

Ingestion If poisoning occurs contact a Doctor or Poisons Information Centre (13 11 26 Australia Wide). Give oxygen & if necessary, artificial respiration. If giving resuscitation wash out patients mouth & lips-do not inhale patients expired air. Remove contaminated clothing & wash skin thoroughly. Seek urgent medical attention.

SAFE HANDLING PROCEDURES

Storage Store in SECURED, windowless but well ventilated area with minimum 2M fence with rain proof cover, fire resistant, removed from direct sunlight, OXIDISING AGENTS (peroxides, hypochlorites), acids, heat sources & food stuffs. Ensure containers are adequately labelled protected from physical damage & sealed when not in use. Containers should be stored off ground.

Spillage If spilt contact emergency services. Wear protective equipment including; full face air supplied or self contained respirator, full body impervious coveralls, butyl or neoprene gloves and boots. Clear area of all unprotected personnel. Absorb spill with sand or similar (if liquid) or if solid, collect and place in containers for disposal.

Transport Class 6.1 Poison. Do not transport with chemicals of class; 1 (Explosives), 3 (Flammable liquids), 5.1 (Oxidizing agents), 5.2 (Organic peroxides), 8 (Corrosives) and foodstuffs.

Waste Disposal Wearing protective equipment - collect (if solid) or absorb with vermiculite or similar (if liquid) treat with strongly alkaline solution of calcium hypochlorite, let stand for 24 hours, absorb with sand or similar and dispose of to an approved landfill site. Contact Australian Health on (09) 368 1711 for additional information.

Fire / Explosion Non flammable. Evacuate area in fire situation and contact emergency services. HIGHLY TOXIC and flammable gases (hydrogen cyanide) may be evolved when exposed to acids, acid salts, carbon dioxide or water - moist air or if heated. Remain upwind and notify those downwind of potential hazard. Full protective equipment (see spill above) including self contained breathing apparatus is recommended when combating fire.

Extinguishing Media Nonflammable. Carbon dioxide extinguishers should not be used as contact with sodium cyanide may result in the evolution of flammable hydrogen cyanide gas.

PHYSICAL AND CHEMICAL

Print Date 03/11/95

Edit Date 19/07/95

Flammability: NON FLAMMABLE
Flash Point: - 17C (HCN)(cc)
Boiling Point: 1496 C
Melting Point: 564 C
ES /TLV: 5 mg/m3 CN (10 ppm H
Evaporation: NOT APPLICABLE

pH: 11.3-11.7 (5%)
% Volatiles: NOT APPLICABLE
Specific Gravity: 1.16
Solubility: 37% @ 20C
Vapour Pressure: 0.76 mmHg @ 800 C

Upper Explosion Limit: 40 %
Lower Explosion Limit: 5.6%

Comment: PRINTED FOR NORMANDY MINING LIMITED

Product Name *CAUSTIC SODA, LIQUID*

Ingredients with Concentration and CAS No.	SODIUM HYDROXIDE	VERY HIGH(>60%)	1310-73-2
	WATER	NOT PROVIDED	7732-18-5

Synonyms SODA LYE; SODIUM HYDROXIDE SOLUTION;
Appearance CLEAR, VISCOUS LIQUID (BULK TANKS, 20 OR 205 L CONTAINERS)
Odour ODOURLESS
Uses GOLD PROCESSING REAGENT; PH MODIFIER;
Supplier I.C.I. 089 470965

Poison Sched: 6 **Haz Chem:** 2R **U.N. #:** 1824 **Class:** 8 **Pkg Grp:** II

HEALTH HAZARD INFORMATION

Eye Corrosive. Severe irritant, exposure may result in pain, redness, corneal burns and ulceration with possible permanent damage.

Inhalation Corrosive. Over exposure may result in mucous membrane irritation, coughing and bronchitis. At high levels; ulceration, intense thirst, lung tissue damage, chemical pneumonitis and pulmonary oedema. Symptoms may be delayed following exposure. Low volatility considerably reduces inhalation hazard unless volatilised.

Skin Corrosive-severe irritant. Contact may result in rash, dermatitis, blistering, severe burns and discolouration. Effects (eg. burning sensation) may be delayed.

Ingestion Highly corrosive - toxic. Ingestion may result in burns to the mouth and throat, nausea, vomiting, abdominal pain and diarrhoea. Large doses may result in ulceration of the gastrointestinal tract, unconsciousness and convulsions.

Hazard Summary Highly corrosive - toxic. Use safe work practices to avoid eye or skin contact and vapour or spray mist generation - inhalation. Chronic or acute exposure at high levels may result in severe skin, eye and respiratory burns with permanent lung and tissue damage.

PRECAUTIONS FOR SAFE USE

Flammability Non flammable. May evolve toxic gases when heated. Contact with most metals may liberate potentially flammable - explosive hydrogen gas.

Reactivity Incompatible with oxidizing agents (eg. hypochlorites, peroxides), acids, (eg. nitric acid), metals (aluminium, potassium, magnesium) and heat sources.

Ventilation Do not inhale vapours. Use in well ventilated areas. In poorly ventilated areas, mechanical extraction ventilation is recommended.

Personal Protective Equipment Faceshield or splash proof goggles, coveralls, PVC or rubber gloves, PVC or rubber apron and PVC or rubber boots are recommended when handling. If spraying, in poorly ventilated areas or where an inhalation risk exists, an approved air supplied respirator is recommended.

PERSONAL PROTECTIVE EQUIPMENT

DMH

Colour Rating RED

Product Name **CAUSTIC SODA, LIQUID**

FIRST AID PROCEDURES

Eye Flush gently with running water, holding eyelids open for 15 minute period. Seek immediate medical attention.

Inhalation Leave area of exposure immediately. If assisting a victim avoid becoming a casualty, wear an approved air supplied respirator where an inhalation risk exists. Remove victim from exposure area & keep warm. If victim is not breathing apply artificial respiration & seek urgent medical attention.

Skin Remove contaminated clothing and gently flush affected areas with soap and water. Seek medical attention if irritation develops. Launder clothing before reuse.

Ingestion If poisoning occurs, contact a Doctor or Poisons Information Centre [13 11 26 - AUSTRALIA WIDE]. Do not induce vomiting. Give water to drink and seek immediate medical attention.

SAFE HANDLING PROCEDURES

Storage Store in cool, dry, well ventilated area, removed from oxidizing agents (eg. hypochlorites), acids, metals, direct sunlight, flammable liquids, heat sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills. Large storage areas should be bunded and have appropriate ventilation systems.

Spillage If spilt, contact emergency services where appropriate. Wear protective equipment including; full face air supplied respirator (where an inhalation risk exists), coveralls, apron, PVC or rubber gloves and boots. Ventilate & clear area of all unprotected personnel. Absorb spill with sand, vermiculite or similar - not combustible or organic materials. Collect & place in sealable containers. Caution - spill site may be slippery.

Transport Class 8 Corrosive. Do not transport with chemicals of class; 1 (Explosives), 4.3 (Dangerous When Wet), 5.1 (Oxidising agents), 5.2 (Organic peroxides), 6 (Poisons), 7 (Radioactives), and foodstuffs.

Waste Disposal SOLUTIONS: Add to large quantity of water and neutralise with 6M Hydrochloric acid (HCl). SOLIDS: Sweep up/collect & dilute by adding to a large quantity of water, neutralise with 6M HCl. Discharge neutralised solutions to sewer with excess water, or alternatively absorb with sand or similar and dispose of to an approved landfill site. Contact Australian Health on (09) 368 1711 for additional information.

Fire / Explosion Non flammable. If product is present in a fire situation, toxic gases may be evolved. Evacuate area and contact emergency services. Remain upwind and notify those downwind of the potential hazard. Full protective equipment including self contained breathing apparatus is recommended when combating fire. Use waterfog to cool intact containers and nearby storage areas.

Extinguishing Media Non flammable. Prevent contamination of drains or waterways, absorb runoff with sand or similar.

PHYSICAL AND CHEMICAL

Print Date 03/11/95

Edit Date 12/07/93

Flammability: NON FLAMMABLE
Flash Point: NOT APPLICABLE
Boiling Point: NOT APPLICABLE
Melting Point: NOT PROVIDED
ES /TLV: 2 mg/m3 SODIUM HYDRO
Evaporation: NON VOLATILE
Upper Explosion Limit: NOT APPLICABLE
Comment: PRINTED FOR NORMANDY MINING LIMITED

pH: > 13
% Volatiles: NOT APPLICABLE
Specific Gravity: 1.01 kg/l
Solubility: SOLUBLE
Vapour Pressure: NOT APPLICABLE
Lower Explosion Limit: NOT APPLICABLE

Product Name ***LIME - UNSLAKED***

Ingredients with Concentration and CAS No.	CALCIUM OXIDE	HIGH(30-60%)	1305-78-8

Synonyms CALCIUM OXIDE;
Appearance WHITE OR GREY GRANULAR MATERIAL
Odour ODOURLESS
Uses DEHYDRATING AGENT; PH MODIFIER; PLASTERING; REAGENT;
Supplier ADELAIDE BRIGHTON CEMENT 08 3000444

Poison Sched: EXEMPT **Haz Chem:** EXEMPT **U.N. #:** EXEMPT **Class:** 8 **Pkg Grp:** III

HEALTH HAZARD INFORMATION

Eye Corrosive. Severe irritant upon contact with powder/ dust. Over exposure may result in pain, redness, corneal burns and ulceration with possible permanent damage.

Inhalation Corrosive. Over exposure to powder - dust (when mixing) may result in severe mucous membrane irritation of nose and throat, coughing and bronchitis at high levels.

Skin Corrosive. Prolonged and repeated contact with powder or wetted form may result in skin rash and dermatitis.

Ingestion Corrosive. Ingestion may result in ulceration - burns to the mouth and throat, nausea, vomiting, abdominal pain and diarrhoea.

Hazard Summary Corrosive. Use safe work practices to avoid eye - skin contact and dust generation-inhalation. Once in the wetted state, an inhalation hazard is not anticipated. Chronic respiratory effects are not anticipated with over exposure at high levels due to the immediate irritant and/or corrosive effects.

PRECAUTIONS FOR SAFE USE

Flammability Non flammable. When mixed with water or upon contact with combustibles contaminated with water ignition may occur.

Reactivity Incompatible with oxidizing agents (eg. hypochlorites), ethanol, acids + interhalogens (eg. chlorine trifluoride). Water contact may increase product temperature 2-3 C.

Ventilation Do not inhale dust/ powder. Use with adequate natural ventilation. Where a dust inhalation hazard exists, mechanical extraction ventilation is recommended.

Personal Protective Equipment Dust proof goggles and PVC or rubber gloves are recommended when handling. Where heavy skin contamination is likely, coveralls/protective clothing are also recommended. Where an inhalation risk exists, an approved Class P1 or P2 particulate respirator is also recommended. At high dust levels, an approved Full Face Class P3 particulate or Powered Air Purifying Respirator (PAPR) is recommended.

PERSONAL PROTECTIVE EQUIPMENT

MG

Colour Rating AMBER

Product Name **LIME - UNSLAKED**

FIRST AID PROCEDURES

Eye Flush gently with running water, holding eyelids open for 15 minute period. Seek immediate medical attention.

Inhalation If over exposure occurs, leave exposure area immediately. If other than minor symptoms are displayed, seek immediate medical attention.

Skin Remove contaminated clothing and gently flush affected areas with soap and water. Seek medical attention if irritation develops. Launder clothing before reuse.

Ingestion If poisoning occurs, contact a Doctor or Poisons Information Centre (13 11 26 - AUSTRALIA WIDE). Do not induce vomiting. Give a glass of water to drink. Seek urgent medical attention.

SAFE HANDLING PROCEDURES

Storage Store in cool, dry area, removed from moisture, oxidizing agents (eg. hydrogen fluoride, phosphorus oxide), acids, ethanol, interhalogens (eg. chlorine trifluoride) and foodstuffs. Ensure packages or storage tanks are adequately labelled, protected from physical damage and sealed when not in use.

Spillage If spilt/ packages damaged (bulk), contact emergency services. Wear protective equipment including; dust proof goggles, Class P1 or P2 particulate respirator (where inhalation risk), coveralls, PVC or rubber gloves and boots. Clear area of all unprotected personnel. Prevent spill entering drains or waterways. Cover spill with moist sand or similar, collect and place in sealable containers for disposal. Avoid generating dust.

Transport Class 8 Corrosive. Do not transport with chemicals of class; 1 (Explosives), 4.3 (Dangerous When Wet), 5.1 (Oxidising agents), 5.2 (Organic peroxides), 6 (Poisons), 7 (Radioactives), and foodstuffs.

Waste Disposal For small amounts; VERY SLOWLY, hydrate (addition of water) and then neutralise with dilute hydrochloric acid (eg. 6N HCl) to pH of 7-8. Dilute and flush to sewer or landfill. For large amounts material can be readily recycled. Contact Australian Health on (09) 368 1771 for additional information.

Fire / Explosion Non flammable. HOWEVER; upon contact with water or acids, sufficient heat may be generated to ignite surrounding combustible materials. Evacuate area in fire situation and contact emergency services. DO NOT USE WATER; use dry chemical or carbon dioxide.

Extinguishing Media Nonflammable. Do not use water for fire fighting as contact will increase heat generation due to hydration. Use dry chemical or carbon dioxide extinguishers only.

PHYSICAL AND CHEMICAL

Print Date 03/11/95

Edit Date 22/03/93

Flammability: NON FLAMMABLE
Flash Point: NOT APPLICABLE
Boiling Point: 2850 C
Melting Point: 2570 C
ES /TLV: 2 mg/m3 (Calcium oxi
Evaporation: NON VOLATILE
Upper Explosion Limit: NOT APPLICABLE
Comment: PRINTED FOR NORMANDY MINING LIMITED

pH: NOT ESTABLISHED
% Volatiles: NOT APPLICABLE
Specific Gravity: 3.40
Solubility: SLIGHTLY
Vapour Pressure: NOT APPLICABLE

Lower Explosion Limit: NOT APPLICABLE

Product Name **HYDROCHLORIC ACID**

Ingredients with Concentration and CAS No.	HYDROCHLORIC ACID	HIGH(30-60%)	7647-01-0
	WATER	NOT PROVIDED	7732-18-5

Synonyms CHLOROHYDRIC ACID; HYDROGEN CHLORIDE; MURIATIC ACID; SPIRITS OF SALT;
Appearance CLEAR, COLOURLESS FUMING LIQUID (BULK CONTAINER)
Odour STRONG PUNGENT ODOUR
Uses ACTIVATED CARBON CLEANING AGENT; GOLD PROCESSING REAGENT; LABORATORY REAGENT;
Supplier **bulky boxes** I.C.I. 08 3418955 **drums** AGENTS SALES & SERVICE 09 4531211

Poison Sched: 6 **Haz Chem:** 2R **U.N. #:** 1789 **Class:** 8 **Pkg Grp:** II

HEALTH HAZARD INFORMATION

Eye Severe irritant - highly corrosive. Exposure may result in pain, redness, conjunctivitis, corneal burns and ulceration with possible permanent damage.

Inhalation Corrosive. Over exposure to acid vapour/fumes may result in mucous membrane irritation and coughing. At high levels; bronchitis, ulceration, intense thirst, lung tissue damage, chemical pneumonitis and pulmonary oedema. Symptoms may be delayed following exposure.

Skin Corrosive-severe irritant. Contact may result in rash, dermatitis, blistering, severe burns and discolouration. Effects (eg. burning sensation) may be delayed.

Ingestion Highly corrosive - toxic. Ingestion may result in burns to the mouth and throat, nausea, vomiting, abdominal pain and diarrhoea. Large doses; ulceration of the GI-tract, oedema, rapid pulse, shock, unconsciousness and convulsions.

Hazard Summary Highly corrosive - toxic. Use safe work practices to avoid eye or skin contact and vapour or spray mist generation - inhalation. Chronic or acute exposure at high levels may result in severe skin, eye and respiratory burns with permanent lung and tissue damage.

PRECAUTIONS FOR SAFE USE

Flammability Non flammable. May evolve highly toxic gases (chlorides, hydrogen chloride) when heated to decomposition. May evolve highly flammable - explosive hydrogen gas when in contact with metals.

Reactivity Strongly incompatible with oxidizing agents, alcohols, alkalis (eg.caustic), active metals (aluminium), some acids (H_2SO_4), dinitroanilines and heat sources.

Ventilation Do not inhale vapours. Use in well ventilated areas. In poorly ventilated areas, mechanical extraction ventilation is recommended.

Personal Protective Equipment Faceshield or splash proof goggles, coveralls, apron, PVC or rubber gloves and boots are recommended when handling. Where heavy contamination is possible a full PVC or rubber chemically resistant suit is recommended. In poorly ventilated areas, or where an inhalation risk exists an approved full face Type B acid gas or air supplied respirator is recommended.

PERSONAL PROTECTIVE EQUIPMENT

DMH

Colour Rating RED

Printed by: NORMANDY MINING LIMITED

Product Name *HYDROCHLORIC ACID*

FIRST AID PROCEDURES

Eye Flush gently with running water, holding eyelids open for 15 minute period. Seek immediate medical attention.

Inhalation Leave area of exposure immediately. If other than minor symptoms occur, seek urgent medical attention. If assisting a victim avoid becoming a casualty, wear an approved full face Type B-acid gas or air supplied respirator (in poorly ventilated areas). If victim is not breathing apply artificial respiration.

Skin Remove contaminated clothing and gently flush affected areas with soap and water. Seek medical attention if irritation develops. Launder clothing before reuse.

Ingestion If poisoning occurs, contact a Doctor or Poisons Information Centre (13 11 26 - AUSTRALIA WIDE). Do not induce vomiting. Give a glass of water to drink. Seek urgent medical attention.

SAFE HANDLING PROCEDURES

Storage Store in secured, cool, dry, well ventilated area, removed from oxidizing agents (eg. hypochlorites), alkalis, most metals, heat sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills. Large storage areas should have appropriate fire prevention and ventilation systems.

Spillage If spilt (bulk), contact emergency services. Clear area of unprotected personnel. Ventilate area where possible. Wear protective equipment including; full face Type B-Acid gas or air supplied respirator, full length PVC coveralls, gloves and boots. Cover with sodium bicarbonate or 50-50 mixture of soda carbonate & calcium hydroxide. Collect & flush with excess water to drain or collect and take to approved landfill. Wash spill area

Transport Class 8 Corrosive. Do not transport with chemicals of class; 1 (Explosives), 4.3 (Dangerous When Wet), 5.1 (Oxidising agents), 5.2 (Organic peroxides), 6 (Poisons), 7 (Radioactives), and foodstuffs.

Waste Disposal Wearing protective equipment detailed above; neutralise with sodium bicarbonate or 50-50 mixture of sodium carbonate and sodium hydroxide - dilute with excess water and flush to drain. Wear appropriate protective equipment detailed in spill when undertaking operation. Clear area of all unprotected individuals and ventilate area where possible. Do not add water to unreacted acid.

Fire / Explosion Non flammable (upon contact with metals - explosive vapour). Evacuate area in fire situation and contact emergency services. Toxic gases (chlorides, hydrogen chloride) may be evolved when heated. Remain upwind and notify those downwind of potential hazard. Full protective equipment (see spill) including self contained breathing apparatus is recommended when combating fire. Use waterfog to cool intact containers and nearby

Extinguishing Media Non flammable. Prevent contamination of drains or waterways, absorb runoff with sand or similar.

PHYSICAL AND CHEMICAL

Print Date 03/11/95

Edit Date 25/01/95

Flammability: NON FLAMMABLE
Flash Point: NOT APPLICABLE
Boiling Point: 108.6 C
Melting Point: - 46.2 C
ES /TLV: 5 ppm Hydrogen chlor
Evaporation: NOT APPLICABLE
Upper Explosion Limit: NOT APPLICABLE
Comment: PRINTED FOR NORMANDY MINING LIMITED

pH: < 1
% Volatiles: NOT APPLICABLE
Specific Gravity: 1.16
Solubility: SOLUBLE
Vapour Pressure: 17.8 mmHg @ 20C
Lower Explosion Limit: NOT APPLICABLE

Product Name *NITRIC ACID*

Ingredients with Concentration and CAS No.	NITRIC ACID	VERY HIGH(>60%)	7697-37-2
	WATER	NOT PROVIDED	7732-18-5

Synonyms AQUA FORTIS; AZOTIC ACID; HYDROGEN NITRATE;
Appearance CLEAR OR YELLOWISH FUMING LIQUID (500ML, 2.25L OR 3000L)
Odour STRONG PUNGENT, CHOKING ODOUR
Uses ETCHING STEEL; MANUFACTURE-EXPLOSIVES & FERTILIZERS; METALLURGY; ORE FLOTATION;
Supplier AGENT SALES AND SERVICE 09 4531211

Poison Sched: 6 **Haz Chem:** 2PE **U.N. #:** 2031 **Class:** 8 **Pkg Grp:** I

HEALTH HAZARD INFORMATION

Eye Corrosive. Severe irritant, exposure may result in pain, redness, corneal burns and ulceration with possible permanent damage.

Inhalation Corrosive. Over exposure may result in mucous membrane irritation, coughing and bronchitis. At high levels; ulceration, intense thirst, lung tissue damage, chemical pneumonitis and pulmonary oedema. Symptoms may be delayed following exposure. Low volatility considerably reduces inhalation hazard unless volatilised.

Skin Corrosive-severe irritant. Contact may result in rash, dermatitis, blistering, severe burns and discolouration. Effects (eg. burning sensation) may be delayed.

Ingestion Highly corrosive - toxic. Ingestion may result in severe burns to the mouth and throat, nausea, vomiting, abdominal pain and diarrhoea. Larger doses may result in severe ulceration of the gastrointestinal tract, unconsciousness, convulsions and death.

Hazard Summary Highly corrosive - toxic. Use safe work practices to avoid eye or skin contact and vapour inhalation. Exposure may result in severe and permanent eye, skin and respiratory damage. Highly toxic and possibly fatal via ingestion and with prolonged skin contact. Upon dilution the potential for corrosive and toxic effects will be reduced.

PRECAUTIONS FOR SAFE USE

Flammability Non flammable. However, flammable upon contact with reducing agents. Toxic gases (nitrous oxides, hydrogen nitrate) may be evolved when heated to decomposition.

Reactivity Incompatible (violently) with combustible organics (eg. wood, cotton, turpentine), metal powders, reductants/ bases (eg. hydrogen sulfide), ammonia and heat sources.

Ventilation Do not inhale vapours. Use in well ventilated areas. In poorly ventilated areas, mechanical extraction ventilation is recommended.

Personal Protective Equipment Faceshield or splash proof goggles, coveralls, PVC or rubber gloves and apron are recommended when handling. Boots are also recommended where heavy contamination is likely. In poorly ventilated areas or where an inhalation risk exists an approved Type B-Acid gas or Supplied air respirator is recommended.

PERSONAL PROTECTIVE EQUIPMENT

DMG

Colour Rating RED

Product Name *NITRIC ACID*

FIRST AID PROCEDURES

Eye Flush gently with running water, holding eyelids open for 15 minute period. Seek immediate medical attention.

Inhalation Leave area of exposure immediately. If other than minor symptoms occur, seek urgent medical attention. If assisting a victim avoid becoming a casualty, wear an approved full face Type B-acid gas or air supplied respirator (in poorly ventilated areas). If victim is not breathing apply artificial respiration.

Skin Remove contaminated clothing and gently flush affected areas with soap and water. Seek medical attention if irritation develops. Launder clothing before reuse.

Ingestion If poisoning occurs, contact a Doctor or Poisons Information Centre (13 11 26 - AUSTRALIA WIDE). Do not induce vomiting. Give a glass of water to drink. Seek urgent medical attention.

SAFE HANDLING PROCEDURES

Storage Store in cool, dry, well ventilated area, removed from combustible organics (eg. wood), metal powders, reducing agents, alkalis, ammonia, direct sunlight & heat sources. Ensure containers are adequately labelled, protected from physical damage & sealed when not in use. Check regularly for leaks or spills. Large storage areas should be bunded and have appropriate fire protection & well ventilated.

Spillage If spilt (bulk), contact emergency services. Clear area of unprotected personnel. Ventilate area where possible. Wear protective equipment including; full face Type B-Acid gas or air supplied respirator, full length PVC coveralls, gloves and boots. Cover with sodium bicarbonate or 50-50 mixture of soda carbonate & calcium hydroxide. Collect & flush with excess water to drain or collect and take to approved landfill. Wash spill area

Transport Class 8 Corrosive. Do not transport with chemicals of class; 1 (Explosives), 4.3 (Dangerous When Wet), 5.1 (Oxidising agents), 5.2 (Organic peroxides), 6 (Poisons), 7 (Radioactives), and foodstuffs.

Waste Disposal Wearing protective equipment detailed above; neutralise with sodium bicarbonate or 50-50 mixture of sodium carbonate and sodium hydroxide - dilute with excess water and flush to drain. Wear appropriate protective equipment detailed in spill when undertaking operation. Clear area of all unprotected individuals and ventilate area where possible. Do not add water to unreacted acid.

Fire / Explosion Non flammable. Evacuate area in fire situation and contact emergency services. Toxic gases (nitrogen oxides, hydrogen nitrate) may be evolved when heated. Remain upwind and notify those downwind of potential hazard. Full protective equipment (see spill above) including self contained breathing apparatus is recommended when combating fire. Use waterfog to cool intact containers and nearby storage areas.

Extinguishing Media Water fog. Prevent contamination of drains or waterways, absorb runoff with sand or similar.

PHYSICAL AND CHEMICAL

Print Date 03/11/95

Edit Date 25/01/95

Flammability: NON FLAMMABLE
Flash Point: NOT APPLICABLE
Boiling Point: 86 C
Melting Point: - 42 C
ES /TLV: 2 ppm (Nitric acid)
Evaporation: NOT APPLICABLE
Upper Explosion Limit: NOT APPLICABLE
Comment: PRINTED FOR NORMANDY MINING LIMITED

pH: ACIDIC
% Volatiles: NOT APPLICABLE
Specific Gravity: 1.36 - 1.42 @15
Solubility: SOLUBLE
Vapour Pressure: 62 mmHg @ 25C

Lower Explosion Limit: NOT APPLICABLE

Product Name **FREEVIS**

Ingredients with Concentration and CAS No.			
	ACRYLATE POLYMER	HIGH(30-60%)	NOT EST.
	INERT INGREDIENTS	LOW(<10%)	NOT EST.
	WATER	HIGH(30-60%)	7732-18-5

Synonyms NALCO REEVIS 905;
Appearance CLEAR COLOURLESS - YELLOW LIQUID (200L PLASTIC LINED DRUM)
Odour LOW ODOUR
Uses ANTISCALANT; FOR USE WITH CLAY BASED ORES; RHEOLOGY MODIFIER; TAILINGS SLURRY VISCOSITY
Supplier NALCO AUSTRALIA 02 3163000
Poison Sched: EXEMPT **Haz Chem:** EXEMPT **U.N. #:** EXEMPT **Class:** EXEMPT **Pkg Grp:** EXEMPT

HEALTH HAZARD INFORMATION

Eye Low to moderate irritant. Direct contact - prolonged exposure may result in lacrimation, pain, redness and conjunctivitis.

Inhalation Low irritant. Over exposure may result in mucous membrane irritation of the nose and throat with coughing. At high levels nausea, dizziness and headache. Due to the low vapour pressure (ie. low volatility) of this product, the potential for an inhalation hazard is reduced.

Skin Irritant. Contact may result in irritation, redness, rash, dermatitis and sensitisation. Toxic effects may result from skin absorption.

Ingestion Moderate toxicity. Ingestion may result in nausea, vomiting, gastrointestinal irritation, abdominal pain and diarrhoea.

Hazard Summary Low toxicity. This product may only present a hazard with eye contact, or prolonged and repeated skin contact. Due to product form an inhalation hazard is not anticipated under normal conditions of use.

PRECAUTIONS FOR SAFE USE

Flammability Non flammable - combustible when dry. May evolve toxic gases (carbon - nitrogen - sulphur oxides, hydrocarbons) when heated to decomposition.

Reactivity Incompatible with oxidizing agents (eg. hypochlorites, peroxides), alkalis (eg. sodium hydroxide) and heat sources.

Ventilation Do not inhale vapours. Use in well ventilated areas. In poorly ventilated areas, mechanical extraction ventilation is recommended.

Personal Protective Equipment Splash proof goggles and PVC or rubber gloves are recommended when handling. Where heavy contamination is likely, coveralls-protective clothing are also recommended. In poorly ventilated areas or where an inhalation risk exists an approved Type A-organic vapour respirator is recommended.

PERSONAL PROTECTIVE EQUIPMENT

Product Name *FREEVIS*

FIRST AID PROCEDURES

Eye Flush gently with running water. Seek medical attention.

Inhalation If over exposure occurs, leave exposure area immediately. If other than minor symptoms are displayed, seek immediate medical attention.

Skin Remove contaminated clothing and gently flush affected areas with soap and water. Seek medical attention if irritation develops. Launder clothing before reuse.

Ingestion If poisoning occurs, contact a Doctor or Poisons Information Centre (13 11 26 AUSTRALIA WIDE). Do not induce vomiting. Seek immediate medical attention.

SAFE HANDLING PROCEDURES

Storage Store in cool, dry, well ventilated area, removed from oxidizing agents, moisture, acids and foodstuffs. Ensure product is adequately labelled, protected from physical damage and sealed when not in use.

Spillage If spilt (bulk), contact emergency services where appropriate. Wear protective equipment including splash proof goggles, Type A-organic vapour respirator, coveralls, PVC or rubber gloves and boots. Ventilate and clear area of all unprotected personnel. Prevent spill entering drains or waterways. Absorb spill with sand or similar, collect and place in sealable containers for disposal.

Transport Not regulated for transport purposes.

Waste Disposal For small amounts absorb with sand, vermiculite or similar and dispose of to an approved landfill site. Contact Australian Health on (09) 368 1711 for additional information if larger amounts are involved. Prevent contamination of drains and waterways as aquatic life may be threatened and environmental damage may result.

Fire / Explosion Non flammable-combustible when dry. Evacuate area in fire situation and contact emergency services. Toxic gases (hydrocarbons, carbon - nitrous - sulphur oxides) may be evolved when heated. Remain upwind and notify those downwind of potential hazard. Full protective equipment (see spill above) including self contained breathing apparatus is recommended when combating fire. Use waterfog to cool intact containers and nearby

Extinguishing Media Dry chemical, carbon dioxide or water fog. Prevent contamination of drains or waterways, absorb runoff with sand or similar.

APPENDIX II - HAZARDOUS PROCEDURES

TAG OUT CV9

BEFORE ENTERING COARSE ORE BIN

AND EMPTY THIS CONVEYOR

REQUIRED STEPS AND SAFETY PROCEDURES TO BE FOLLOWED BEFORE ENTERING THE A .G. MILL.

Task	Danger	Safety Apparel Required	Special Requirements.
Ensure that the mill is ground out properly before shutdown.	Excessive slimes make the charge very slippery to walk on.	Helmet, safety glasses and boots.	(i) Must only be a clean bed of coarse material for people to walk on.
Ensure that CV9 is completely empty before shutdown.	Rocks could fall off head of conveyor.	Helmet, safety glasses and boots	(i) Conveyor should be racked out and tagged.
Pull back feed chute.	Cable break.	Helmet, safety glasses and boots	(i) Ensure that the chute trolley tracks are clear. (ii) Keep away from winch cable whilst winch operating.
Put mesh cover in place.	Worker could fall through hole to floor below.	Helmet, safety glasses and boots. Parachute.	(i) The area around the entrance to the mill should be hosed off and made safe.
Ensure that bed is horizontal.	Danger of worker slipping worse if bed sloped.	Helmet, safety glasses and boots	(i) May be necessary to inch back and forth to get bed horizontal. Workers must be clear of mill beforehand.
Have the electricians rack out the 3.3Kv breaker in the powerhouse and then padlock it.	Accidental startup would kill anyone unfortunate enough to be in the mill.	Helmet, safety glasses and boots.	(i) Advise the electricans before hand of the impending shutdown. (ii) Racking out can only be done by an electrician.
Hose out the mill.	Loose rocks on shell overhead and slimes on ore make the charge slippery.	Helmet, safety glasses and boots	(i) One person with observer to check for loose rocks in shell. Hose down or dislodge with bar. (ii) May be necessary to restart mill to get rid of excess water or alternatively pump it out.
Person in charge of work to be done to tag the padlock.	Someone could rack the mill back in whilst people working inside it.	Helmet, safety glasses and boots.	(i) Must complete the tag properly - Name, date, time and reason for placement of tag.

Required steps and safety procedures to be followed before entering the A.G.Mill. (Continued)

Task	Danger	Safety Apparel Required	Special Requirements.
Person in charge to make entry in powerhouse log book.	Minimum.	Helmet, safety glasses and boots.	(i) Specify time and reason for shutdown and then sign alongside the entry.
All workers who will be entering the mill must sign the Access Permit.	Could be restarted before they get out.	Helmet, safety glasses and boots.	(i) The person in charge must make sure that all workers who will be working in the mill have signed the Access Permit.
Lockout switch must be put to manual position and tagged by all workers who are going to enter mill.	Inching could be started whilst worker still in mill.	Helmet, safety glasses and boots	(i) Each worker must place his own properly completed tag on the switch.
Entering mill	Rocks falling from shell. Floor could still be slippery. Heat during summer.	Helmet, safety glasses, ear protection, gloves and boots.	(i) No single person should enter mill without an observer outside the mill entrance. (ii) All workers should be advised to warn others if throwing material out through feed entrance. (iii) Fooling around whilst inside mill strictly forbidden.
Working in mill	Fatigue.	Helmet, safety glasses, gloves, ear protection and boots. Glasses should be treated with anti-fog spray or cloth.	(i) During summer workers should not stay inside mill for periods in excess of 30 minutes without taking a break. If possible rotate between inside and outside work. (ii) Maintain adequate fluid intake.

Required steps and safety procedures to be followed before entering the A.G.Mill. (Continued)

Task	Danger	Safety Apparel Required	Special Requirements.
Inching the mill.	Charge will slide.	Helmet, safety glasses and boots.	(i) All workers to get out of mill. (ii) All workers to take tags off lockout switch. (iii) Person in charge only to inch mill and check that the area around the mill is clear of workers.
Resuming work inside the mill.	Rocks falling from shell. Floor could still be slippery. Heat during summer.	Helmet, safety glasses, gloves, ear protection and boots	(i) Lockout switch to be put in off position. (ii) All workers to put their tags back in place. (ii) One person with observer to check for loose rocks in shell before the other workers enter mill.
Leaving mill when work completed.	Equipment may be left in mill.	Helmet, safety glasses, gloves and boots.	(i) Supervisor to check that all equipment is out of the mill. (ii) Mesh covering to be removed. (iii) Feed chute to be winched back into place. (iv) All workers to remove tags. (v) Lockout switch to be put in on position.
Access permit to be completed and cancelled.	Minimum if above steps completed properly.	Helmet, safety glasses and boots.	(i) All workers to sign out on the permit. (ii) Person in charge to cancell the permit and complete a cancellation of access permit docket. (iii) Person in charge to make cancellation entry in powerhouse log book. (iv) Person in charge to remove his tag from the padlock on the 3.3Kv breaker. (v) Electricians to rack the mill back in.
Starting mill	Workers may not be clear.	Helmet, safety glasses, ear protection and boots.	(i) Remove tag and rack CV9 back in. (ii) Check that all workers are clear of mill.

THE REQUIRED STEPS AND SAFETY PROCEDURES TO BE FOLLOWED WHEN MIXING CYANIDE.

Task	Danger	Safety Apparel Required	Special Requirements.
Carting boxes to hoist.	(i) Minimum if no damage to box. (ii) If box damaged possible danger from NaCN dust and/or if water has entered the box danger from HCN fumes	(i) Helmet, safety boots and glasses. (ii) Full safety apparel. Helmet, mask, glasses, rubber gloves, plastic apron or weatherproof clothing.	Arrange boxes beneath hoist so that all round access is allowed and traffic to mill is not hindered. ***Any pellets spilt from box must be shovelled up along with contaminated dirt.***
Addition of 200 litres of Caustic to mixing tank.	Assume maximum - a line could burst. Contact with skin causes severe burns.	Full safety apparel. Helmet, mask, glasses, rubber gloves, plastic apron or weatherproof clothing	(i) Drop valve on mixing tank to be closed. (ii) Switch circuit to manual at gold room control panel (iii) Valves at pump switched to divert caustic to mixing tank. (iv) Record meter reading and the start pump. (v) After 200 litres pumped stop pump; pull out stop switch and switch valves back to normal. (vii) Put circuit back to auto. (viii) Record start & finish meter readings on log sheet.
Removing straps from boxes	As in sections (i) and (ii) above.	As in section (i) and (ii) above.	Keep straps together for later removal to tip for burning.
Removing lids from boxes	Minimum if no damage to inner seal but this cannot be guaranteed so expect HCN gas.	Full safety apparel. Helmet, mask, glasses, rubber gloves, plastic apron or weatherproof clothing.	At this stage the onlooker, wearing full safety apparel must be present by hoist controls.

Required steps and safety procedures to be followed when mixing cyanide (continued)

Task	Danger	Safety Apparel Required	Special Requirements.
Cut slits in plastic cover so as to allow the lifting loops to be pulled out.	Assume HCN fumes present as bulky bag may be damaged and moisture may have entered it.	Full safety apparel. Helmet, mask, glasses, rubber gloves, plastic apron or weatherproof clothing.	Hoist operator to monitor actions of operator below and manoeuvre lifting frame into position when required by the operator below.
Attach lifting loops to lifting frame.	Assume HCN fumes present as bulky bag may be damaged and moisture may have entered it.	Full safety apparel. Helmet, mask, glasses, rubber gloves, plastic apron or weatherproof clothing.	When the loops are attached to the frame and the operator below is clear lifting of the bag may commence.
Lifting and dumping of cyanide into mixing tank.	Assume maximum since pellets being dumped may have been in contact with moisture.	Full safety apparel. Helmet, mask, glasses, rubber gloves, plastic apron or weatherproof clothing.	(i) Open swing flaps and move bag into mixing chamber. (ii) Lower bag onto cutting blades. (iii) Shake bag vigorously to ensure that it is entirely empty.
Remove empty bulky bag from mixing chamber and lower it onto truck.	Assume maximum since pellets being dumped may have been in contact with moisture.	Full safety apparel. Helmet, mask, glasses, rubber gloves, plastic apron or weatherproof clothing.	(i) Close flaps as soon as bag leaves the mixing chamber. (ii) Ensure truck in position and operator clear before commencing to lower bag.
Repeat above procedures to lift and empty the remaining bags.	As above - assume maximum danger possible from gas and dust.	Helmet, mask, glasses, rubber gloves, plastic pron or weatherproof clothing.	As per above procedures.

Required steps and safety procedures to be followed when mixing cyanide (continued)

Task	Danger	Safety Apparel Required	Special Requirements.
Place lids back on the boxes and return same to storage area outside of the cyanide yard.	Minimum.	Helmet, safety glasses, gloves and safety boots.	Stack neatly. Do not put lids on upper tier boxes as they will blow away. Stack between boxes.
Disposal of the empty bags, plastic liners and straps.	Assume maximum but if no moisture evident when bags removed dust would be the greater danger.	Helmet, mask, glasses, rubber gloves, plastic pron or weatherproof clothing	(i) Bags and all straps must be taken to the dump and burned immediately.
Clean up	Minimum.	Helmet, glasses, safety boots, apron and gloves	(i) Hose off truck tray into adsorption floor bund. (ii) Hose off protective clothing.
Topping up of mixing tank. ***Enter box usage in reagent book and on daily mill log sheet.***	Minimum - no exposure required.	Helmet, safety boots and glasses.	(i) Open water addition valve to mixing tank. (ii) Approximately 45 mins later the high level alarm will sound. Close the valve. (iii) Start the agitator and leave it running for four hours. (iii) When ready and required open the dump valve partially and allow mix to run slowly into the holding tank.

REQUIRED STEPS AND SAFETY PROCEDURES TO BE FOLLOWED TO ALLOW SAFE ACCESS TO THE COARSE ORE BIN.

Task	Danger	Safety Apparel Required	Special Requirements
Inspect inside of bin from top of bin.	Bin may not have been completely emptied of loose rock.	Helmet, safety glasses and safety boots. Gloves must also be worn if removing coarse ore slot pins.	(i) Remove all pins from coarse ore slot feeders (ii) from top of bin ensure that the discharge slots are completely empty.
Ensure feed conveyor empty.	Ore may fall off head of conveyor into bin.	Helmet, safety glasses and safety boots.	(i) CV6 should be completely empty.
Rack out feed conveyor.	Crusher operator may inadvertently start feeding ore to bin.	Helmet, safety glasses and safety boots.	(i) Person in charge of work to be done to rack out CV6 and tag it also.
Clear rocks from top of bin.	May fall into bin.	Helmet, safety glasses and safety boots. Safety harness if access to spillage slots on top of coarse ore bin required.	(i) All rocks, etc, that could fall into the bin must be removed before any worker enters the bin. (ii) Must have an observer if it is necessary to clear rocks from around the C.O.Bin spillage slots.
Complete mechanical access permit.	Feed conveyor could be started at end of work whilst worker still in bin.	Helmet, safety glasses and safety boots.	(i) All workers entering the bin must tag CV6 and sign the access permit before hand.
Removal of all buildup outside and immediately inside door by front end loader.	Rock will be hanging up inside bin. Dust inhalation.	Helmet, safety glasses, paper mask and safety boots.	(i) Clear buildup adjacent door prior to moving right into the bin. (ii) Apron feeders to be in manual and operated when requested by loader operator.
Removal of centre build up between coarse ore bin slots feeders.	Loader could be trapped on feeder, endangering operator and damage may occur to both loader and slot feeder. Dust inhalation.	Helmet, safety glasses, paper mask and safety boots.	(i) Must ensure that the feeder is completely full and not just hung up and it must be covered with at least fifty cm of ore to prevent damage to feeder and allow safe access for the loader.
Run slot feeders completely empty.	May be just hung up. Extremely dangerous to move across them. Dust inhalation.	Helmet, safety glasses, paper mask and safety boots.	(i) If slot feeders will not run empty use the backhoe to break through the build up. Do not move the machine across the feeder.

Required steps and safety procedures to be followed to allow safe access to the coarse ore bin. (Continued)

Task	Danger	Safety Apparel Required	Special Requirements
Remove all excess ore using backhoe.	Machine could slip into feeder. Dust inhalation.	Helmet, safety glasses, paper mask and safety boots.	(i) Do not put backhoe ram supports too close to feeder. Observer to start apron feeder when requested. (ii) Using backhoe drag all excess ore into slots. (iii) Using backhoe make edge of slots completely safe for worker access.
Removal of loose rocks that could fall into the slot feeders.	Worker could fall into slot feeder. Dust inhalation	Helmet, safety glasses, paper mask and safety boots. Safety harness if surrounding ore particularly loose.	(i) Using shovel shove any loose rocks into the slot feeder/activator. (ii) Make sure that the level of the ore along the edge of the feeder is lower than the top edge of the feeder.
Place `Men Working Below' signs at access doors.	Worker could throw a rock into the slot feeder hitting a worker in it.	Helmet, safety glasses and safety boots.	(i) Must be put in place prior to work commencing inside the feeders.
Working inside slot feeders.	Fall when climbing into the feeder.	Helmet, safety glasses and safety boots. (step ladder advisable). Boiler makers to wear proper welding mask/goggles and jacket also.	(i) Apron feeders must be racked out and then tagged by each person who will be working inside slot, (ii) Maintenance personnel must complete their own mechanical access permit (iii) No person should work inside a slot feeder without an observer nearby.
Completion of mechanical access permit.	Worker or equipment could still be in feeder at start of feed conveyor. Dust inhalation.	Helmet, safety glasses and safety boots. Loader operator to wear paper mask.	(i) Ensure all equipment has been removed from bin. (ii) All workers to remove their tags and sign out on the permit when their work is completed. (iii) Loader operator to fill in coarse ore bin slots and block off access doors. (iv) Loader operator to sign out on permit.
Cancellation of the Mechanical Access Permit.	None	Helmet, safety glasses and safety boots.	(i) Person in charge to remove his danger tag(s) and complete cancellation of mechanical access docket. (ii) Person in charge to rack the conveyors back in.